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Water Marketing in the Southwest—Can Market Prices Be Used to Evaluate Water Supply Augmentation Projects?

Bonnie Colby Saliba, David B. Bush, and William E. Martin

Abstract

Price behavior over time in selected western water markets is observed and assessed as a useful measure of the economic value of water. Market characteristics that may distort prices include imperfect competition, third-party effects, institutional and hydrologic uncertainty, and equity considerations. Nonmarket valuation techniques are useful in supplementing market price information.

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MANAGEMENT IMPLICATIONS

Valuation of incremental changes in water availability is an important issue in the Western United States as agriculture, industry, energy development, and population growth exert increasing pressure on limited water resources. Water yields can be significantly increased by management practices on public lands, raising questions regarding the value to society of these potential increments. Strong pressures for marketing water exist as water in many regions is fully appropriated and new uses can be accommodated only through transfer from established uses. In some areas, market activity has been occurring for several decades. In others, institutions that govern water allocation are only slowly becoming receptive to the market transfer of water rights. This report analyzes selected water markets in the Western United States by measuring water prices over time and by evaluating the appropriateness of market prices as measures of the economic value of incremental increases in water supplies.

Equity issues, external effects of market activity, imperfect competition, and legal, economic, and hydrologic uncertainty are identified as market characteristics that may distort prices as indicators of water values. Western water markets exhibit these characteristics to varying degrees, and the appropriateness of using a particular set of prices must be evaluated case by case, based on a thorough understanding of market activities and price formation processes. Even if there are no conceptual reasons to question whether observed prices are appropriate measures of value, there are a number of practical problems in using market prices. Prices are rarely a matter of public record and price data must often be elicited from market participants. Several types of water commodities and market prices are found in each of the regions studied, and it must be determined which, if any of them, are appropriate for valuing augmented yields.

Market prices will not usually provide an appropriate measure of value for public decision-making and should be used as one of several sources of information on water values. Under most circumstances, nonmarket valuation techniques would be helpful in supplementing price data generated by market transactions. Use of both market and nonmarket information is recommended to ensure that agencies seeking to value increased water supplies use measures that approximate willingness to pay for additional water.

INTRODUCTION

RESEARCH OBJECTIVES AND SCOPE

Public agencies are often faced with the task of estimating costs and benefits associated with water supply augmentation projects. Proposed projects may include construction of water storage and delivery facilities or, in the case of the Forest Service, U.S. Department of Agriculture, changes in land management practices that will alter the quantity and timing of water yields. One of the difficulties in estimating project benefits involves assigning an appropriate value to increments in water supply attributable to the project. The broad purpose of this research was to investigate water markets in the Southwest and, based on that investigation, to evaluate the usefulness of market water prices as measures of value for public project evaluation and water policy development.

To accomplish this overall purpose the research had several major objectives:

- Describe and compare the legal institutions relevant to market transfers of water in Arizona, California, Colorado, Nevada, New Mexico, and Utah.
- Identify and describe water markets in selected study areas.
- Analyze and compare markets in terms of historical development, supply and demand, structure, and the competitiveness of the price determination process.
- Compile data, where available, on water prices over time in selected markets.
- Evaluate the appropriateness of using market prices as measures of the economic value of incremental changes in water supplies.

Descriptions and comparisons of selected water markets and observed price data are presented. Theoretical and practical considerations that affect the appropriateness and usefulness of observed prices as measures of value for use by public agencies are discussed. Prices generated within the water markets investigated in this study are evaluated and analyzed. Implications for valuing incremental water yields from public lands are summarized. Finally, recommendations are offered on the use of market prices by public agencies, as well as suggestions for future research efforts complementary to the objectives and results of this study.

GENERAL CHARACTERISTICS OF SOUTHWESTERN WATER MARKETS

A water market may be defined as any institutional setting within which the right to use water is bought, sold, rented, or traded among consenting parties. Water rights are frequently transferred incidentally as a part of a transaction involving land, improvements and other goods. However, this research focuses on areas where water rights are recognized as having independent value and where transfer of water rights is the primary purpose of transactions involving water. Western water markets are generally in a rudimentary state of development compared to markets for other natural resources, such as land, natural gas, timber, or minerals. Markets often have poorly developed channels for communicating information on prices and sales, and for bringing potential buyers and sellers together. Even in areas where active and well-developed markets exist, only a small proportion of total water supplies are likely to be included in market transactions. Federal project water, a significant proportion of water supplies in many areas, has not been readily transferable and usually is not priced to reflect local water values.[1] It is provided on a contractual basis at rates that will cover project repayment obligations only.

Water markets operate in the broad context of western water law and institutions. Several common characteristics serve to distinguish water institutions in the Southwest from other regions in the United States. Water use in the Southwest has been dominated by irrigated agriculture. Early settlement in the Southwest centered around primary industries such as mining, ranching, and agriculture. Irrigated agriculture currently represents a minor portion of the income generated in many Southwestern States. Yet, this sector is still the predominant user of water throughout the region.

Irrigated agriculture (and to a lesser extent, mining) generated demand for water that the seasonal and unpredictable surface water resources of the Southwest could not satisfy. Water users built systems to capture, store, and transport water to bring it to where it was demanded, at the proper time and in the desired quantities. The pattern of water resource development reflected a fundamental reality of the arid West—potentially productive lands frequently were located distant from riparian areas. Typically, water diverted and stored at only a few strategic locations along a stream system supports a network of users located miles away from the source.

Separation between the point of diversion and the place of use grew ever wider when state and federal governments began ambitious land and reclamation programs early in the 20th century. As "native" sources of water were developed, water was transported across greater distances. Systems of pipes, pumps, reservoirs, and canals permitted the transportation of tens or even hundreds of thousands of acre-feet of water per year across mountain ranges and entire hydrologic basins to areas of growing water demand.

Increasing development of limited water resources led to conflicts among competing water users. Coincident with the physical development of water resources, laws and institutions evolved to address the issues of ownership, access, and water rights distribution peculiar to the Southwest. English common law and riparian system of water rights, predicated on a close association between water resources and the land from which they originated, were poorly suited to the arid conditions that influenced water resources development and use in the West. Riparian water law was inappropriate for development of water resources in the West, because it provided for the use of water at locations adjacent to water sources only. The legal doctrine of prior appropriation, first developed by miners in California during the gold rush of 1849, soon became almost universally accepted throughout the West as the legal basis for defining and allocating property rights in water. Under the appropriation system, water could be withdrawn from the water source and used in distant locations. Water rights were defined not in terms of the ownership of land adjacent to a watercourse, but in terms of "beneficial use." That is, the use to which water was put defined the extent of a user's property right in water.

The Southwestern States have experienced rapid rates of population and economic growth since the Second World War. Concurrent with this growth, there has also been a significant structural change in regional economics. While irrigated agriculture remains the predominant water user region-wide, the nonagricultural sectors of the economy now employ all but a fraction of the work force and earn the great bulk of all income. The construction, manufacturing, service, and government sectors of the economy are competing for land and water resources once predominantly devoted to agriculture.

Until fairly recently, the role of state, regional, local, and private water organizations was two-fold — first, to develop water resources and acquire water rights, and then to ensure that the distribution and use of those rights among the water users concerned was fair and equitable. It was not, however, the primary responsibility of water organizations to ensure that water use also was efficient. So long as water supplies were inexpensive to develop, undeveloped resources remained abundant, and grossly wasteful practices avoided, water users were largely insulated from outside pressures to put their resources to the best economic use.

The western water economy in the second half of the twentieth century has been characterized by rapidly rising water costs. Demands for federally funded water projects grew in size, sophistication, and cost as ever larger amounts of public capital were required to draw water from increasingly less accessible sources. The era of cheap and abundant western water has ended. The federal government is increasingly reluctant to commit funds to projects whose costs continue to spiral upwards. Total costs for the Central Utah Project are estimated to approach $1.8 billion.[2] The Animas-La Plata Project was pushed through Congress only after the original design was scaled down considerably, from a cost in excess of $800 million down to an estimated $572 million.[3] The Central Arizona Project, touted as one of the last and greatest of federal water projects, will cost over 3.3 billion dollars to complete.[4]

Emphasis in public water resource policy has begun to shift from supply enhancement towards supply and demand management. A report prepared in 1986 for the Western Governors' Conference stated that "the most effective role of the U.S. Bureau of Reclamation is changing from one of supplying capital for large new water projects to helping the West enhance the efficiency of use of the water that the Bureau already provides."[5] Similar conclusions might be drawn about the changing roles of state and local governments and private water agencies. As quantities of available new water supplies diminish, interest in improving the efficiency of use of existing water supplies grows. One of the most effective means of improving the efficiency of water use is to reallocate supplies from relatively inefficient or low-valued uses to more efficient, higher-valued uses. Increasing demand for flexible mechanisms to optimally reallocate existing water resources has led to an exploration of the potential for decentralized reallocations through voluntary market exchanges.

In some areas of the Southwestern United States, water market activity has been occurring for some time. In other areas, institutions are only now starting to respond to pressures for market transfers of water. This report describes and evaluates the structure, prices and institutional characteristics of specific southwestern water markets.

The general study area for the project, which covers the arid and semiarid regions of the Southwestern United States, includes the States of Arizona, California, Colorado, Nevada, New Mexico, and Utah. Within each state one or two "market areas" were identified for in-depth study. These areas are shown on figure 1. Four basic criteria were used to select the market areas.

First, each area needed to have well-defined geographical boundaries. The water markets studied exist within relatively closed systems, though none is absolutely closed to the transfer of water into or out of its areas.

Second, each market was characterized by an economic scarcity of water resources. If water were available to meet all potential demand at prevailing prices and costs of obtaining water there would be no incentive for market activity. The scarcity criteria did not limit the study to areas in which absolutely no additional water resources could be appropriated. Some market areas investigated remain open to either limited new appropriations or to the importation of additional water supplies. In each of these markets, however, new water rights are generally either (1) restricted in quantity or purposes of use, (2) legally difficult to obtain, or (3) prohibitively expensive to develop. Therefore, purchase of existing water rights is an attractive option to users desiring additional water.

Figure 1.—Southwestern water market study areas.

Third, active markets with some history of water transfers continuing up to the present time were selected. Locations with low levels of activity were of less interest because of sporadic price data. The observation of both changes in market structure and price levels over time is an important means of evaluating market processes.

Finally, it was important that information on market transactions be available. Some areas were rejected because the records on market transactions were too dispersed, too difficult to obtain, and/or too poorly maintained to provide meaningful information.

DESCRIPTION OF DATA

Lack of secondary sources containing detailed price observations necessitated extensive fieldwork. A major source of information was price data obtained from individuals familiar with market transactions.

An effort was made in the study to render all price observations uniform and comparable over time. Unless otherwise indicated, all prices were adjusted, using the Gross National Product (GNP) price deflator, to equivalent 1986 dollar values. The uniformity of price observations is affected by the definition of the water commodity being traded. Several conventions were adopted in this report in order to clarify the meaning behind the comparison of prices among various water rights.

Water rights may be transferred in perpetuity (sold) or temporarily (rented). The transfer of a perpetual water right gives the holder access to water resource indefinitely, that is, the right is bought or sold. A temporary, or seasonal transfer gives the holder access to the water resource for only a certain length of time, that is, the right is leased or rented. Most transactions described in this study were sales of perpetual water rights.

It is important to distinguish between the right of diversion and the consumptive use portion of a water right. Diversion rights refer to the maximum quantity of water that may be drawn for use. Consumptive use refers to the portion of that diversion right that may be removed permanently from the hydrologic system. Under many systems of water law, only the consumptive use portion of a water right may be transferred, that is, the historical level of return flows occurring in the system of origin cannot be reduced as a result of the transfer. Unless otherwise indicated, all transfers described in this report refer to the maximum quantity of water the buyer is allowed to divert. If the described transfer has only been proposed but is not yet in effect, then the quantity described usually refers to the quantity historically diverted by the prospective seller.

Water rights are quantified by flow rate or by volume, and sometimes in terms of both. Flow rate measures are usually expressed in cubic feet per second, while volumetric limits are most often measured in acre-feet (over a fixed period of time, usually a year). Unless otherwise indicated, all transfers are expressed in terms of acre-feet per year.

Water rights are usually limited by a specified maximum level of diversion, but hydrological shortfalls or the system of established priorities among water rights may prevent a right from producing its maximum potential yield. In addition to the allowable level of diversion, therefore, prospective buyers of water rights may also be concerned with the long-term average expected yield, the minimum possible ("firm") yield, and the variability of the yield. Wherever possible, in this report water rights transfers are quantified in terms of the known long-term average yield.

MARKET DESCRIPTIONS AND COMPARISONS

SOUTHERN ARIZONA

Description of the Study Area

The Arizona market areas studied are the Tucson and Phoenix Active Management Areas (AMAs), two of the four AMAs created under the Arizona Groundwater Management Act of 1980. The Phoenix AMA includes the Phoenix metropolitan area and most of Maricopa County. The Tucson AMA includes the Tucson metropolitan area and parts of Pima, Pinal, and Santa Cruz counties. Figure 2 shows the AMAs along with the Central Arizona Project aqueduct.

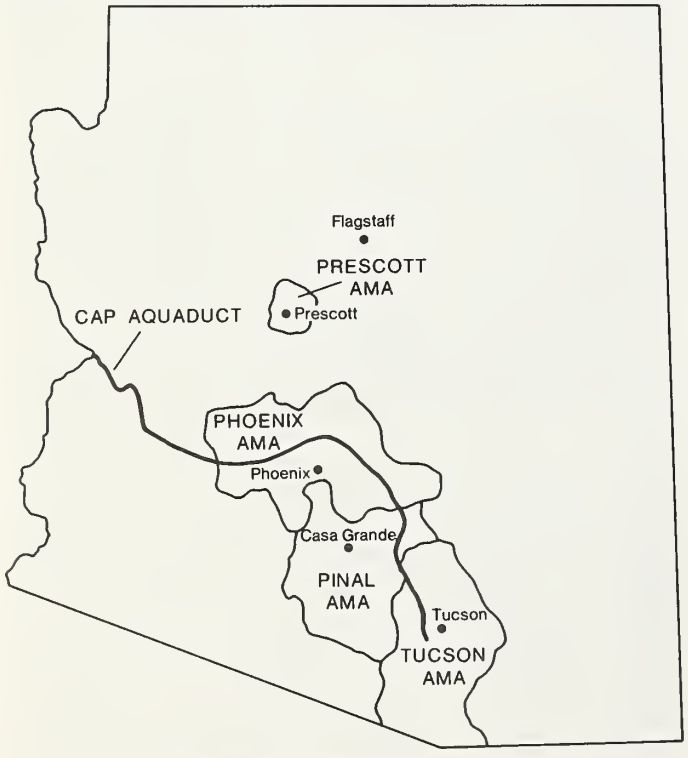

Figure 2.—Southern Arizona.

Approximately 60% of Arizona's annual average water usage (roughly 8.2 million acre-feet) is derived from groundwater sources. The remaining 40% comes from developed surface water sources.[6] The Salt River Project (SRP) provides substantial quantities of surface water from the Salt and Verde Rivers for users in the Phoenix AMA. Phoenix area surface water supplies are supplemented with groundwater pumping. In contrast, water users in the Tucson AMA are completely dependent upon groundwater pumping for their supplies. Available water supplies in both AMAs will increase as Colorado River water is delivered via the Central Arizona Project (CAP). Limited CAP deliveries began to the Phoenix area in 1985, and the project will begin serving the Tucson area in the early 1990s.

Over 85% of the annual water supply in Arizona is currently used by irrigated agriculture.[6] The number of irrigated acres in the State peaked in the early 1960s, and since then has been shrinking as farmland is retired for urban development. While agriculture has declined in economic importance, the nonagricultural sectors of the economy around Tucson and Phoenix are expanding at a rapid pace.[7]

The CAP has changed in purpose and function over time as the political economy of water in Arizona has changed. As originally conceived, it was meant to be a supplemental water supply for irrigation in Central Arizona. By the time construction of the aqueduct reached its midpoint in the early 1980s, the project had become a component of a comprehensive state program of conserving scarce groundwater resources for urban development. Recently the CAP has begun to assume an additional role as a mechanism for water transfers from agriculture to urban users. The 300-mile-long canal links Phoenix to the Colorado River and, when completed, will convey water all the way to Tucson. The aqueduct connects scattered Arizona groundwater and surface water systems where no such linkage existed before. Several proposals are currently under evaluation by the cities of Phoenix, Scottsdale, and Mesa and several private enterprises to use the CAP for interbasin water exchanges and transfers all across central Arizona.

Water Laws and Institutions

Surface Water Rights

Arizona has a dual system of water rights. Surface water rights were developed under the appropriation doctrine common to the Western United States. Groundwater rights, however, are managed under a permit system.[8]

Before 1962, appropriative rights to surface waters were not transferable by their holder to locations other than those specified in the original granting of the right. The only exception arose when the original site was destroyed or impaired by natural calamity. Under such circumstances the right could be moved with the approval of the appropriate administrator or by court order. In 1962 this legal constraint was removed and surface

water rights became transferable, in principle, to new locations provided that the rights of existing appropriators were not impaired. However, transfers continue to be hindered by numerous legal and hydrologic limitations and few have actually taken place.[7]

Groundwater Rights

The passage by the Arizona legislature of the Groundwater Management Act of 1980 accomplished three purposes. First, it created a Department of Water Resources to regulate water resource development and use in the State. Second, it explicitly defined and qualified groundwater rights. Third, it established an agenda for groundwater management.

Under the Act four administrative regions, or Active Management Areas (AMAs), were created under the Department of Water Resources to grant and manage water rights as defined in the legislation and to establish and administer water conservation and supply augmentation programs. The objective of the water conservation and supply augmentation plans is to eliminate virtually all groundwater overdraft in Arizona by the year 2025.

There are four basic classes of legally recognized groundwater rights within the AMAs—exempt withdrawals, grandfathered rights, service area rights, and groundwater withdrawal permits. Withdrawals of groundwater for nonirrigation domestic uses from wells with pump capacities of not more than 35 gallons per minute, or for non-irrigation commercial uses not exceeding 10 acre-feet per year, are exempt from most regulation under the law. Nonirrigation uses include the irrigation of less than 2 acres of land. Individuals may continue to appropriate water for exempt purposes in AMAs, so long as they conform to rules on groundwater well spacing. These regulations are intended to mitigate the adverse impact that a new well could have on nearby groundwater pumpers.

There are three types of grandfathered rights (GFRs): irrigation GFRs, Type I nonirrigation GFRs, and Type II nonirrigation GFRs. An irrigation GFR applies to two or more acres irrigated for the purpose of growing plants for sale or human consumption or to use as feed for livestock or poultry. Irrigation GFRs may be converted to nonirrigation use, but no other water right may be converted to an irrigation GFR. Irrigation GFRs are limited to lands irrigated during the historical period January 1, 1975 to January 1, 1980.

The quantity of an irrigation water right on a particular parcel of land is formulated by the local AMA on the basis of three factors: the water duty per acre, the number of grandfathered acres, and the number of water duty acres. The irrigation water duty is a measure of water use per acre, based on the historical period January 1, 1975 to January 1, 1980. The number of water duty acres is the maximum number of grandfathered irrigation acres that were irrigated during any one of the eligible years. Because of crop rotation practices, the number of water duty acres may be significantly less than the total number of grandfathered irrigation acres.

The maximum quantity of water that may be used per grandfathered irrigation acre is the product of the water duty and the ratio of the number of water duty acres to the number of grandfathered acres. (For example, if the water duty is equal to 4 acre-feet per acre, and there are 80 water duty acres and 100 grandfathered irrigation acres, the maximum water allowance per grandfathered irrigation acre is 4 x (80/100) = 3.2 acre-feet). Irrigators may choose in any year to irrigate all of their grandfathered irrigation acres and spread out their water rights, or they may irrigate fewer acres and concentrate their water use. The 1980 Groundwater Management Act mandates that water conservation requirements must increase over time. Each AMA will progressively reduce irrigation water duties. Because the number of grandfathered and water duty acres on any given parcel of land will not increase, the total water available for irrigation will gradually diminish.

Type I non-irrigation GFRs apply to farmland retired from irrigation after January 1, 1965 in anticipation of a specific non-irrigation use. Type I GFRs recognized in 1980 with the passage of the Groundwater Management Act are granted 3 acre-feet per acre. A Type I right converted from a retired grandfathered irrigation right subsequent to 1980 allows a right-holder to pump the lesser of 3 acre-feet of groundwater per acre from the retired land or the maximum water allowance per grandfathered irrigation acre.

Type II non-irrigation GFRs apply to non-irrigation withdrawals of groundwater that occurred when the AMAs were established. Generally the quantity of water assigned to a Type II right equals the maximum amount of water withdrawn and used for non-irrigation purposes in any 1 of the 5 years before the designation date of the AMAs. No new Type II rights may be created after the designation of an AMA.

Cities, towns, private water companies, and irrigation districts have "service area rights" to withdraw and transport groundwater. The groundwater law defines the service area of a city, town, or private water company as the area of land actually served by the entity and any additional areas that contain an operating distribution system owned by the entity and used primarily for the delivery of non-irrigation water.

A city, town or private water company has the right to withdraw as much groundwater from within its service area as it needs to serve the residents and landowners within the service area. The quantity of water legally available to a service area is therefore not fixed and may expand over time. However the state plans to limit the expansion of service area rights through mandatory reduction in per capita water use within each service area.

Those who are not eligible for GFRs or service area rights may obtain the right to withdraw and use groundwater for new or expanded nonirrigation purposes by applying for a temporary groundwater withdrawal permit. If certain criteria are met, the Department of Water Resources may issue such permits. Groundwater withdrawal permits specify limits on both the duration and quantity of withdrawals.

In addition to appropriated surface water rights and permitted groundwater rights, there are two other types of water rights available within AMAs—CAP water and sewage effluent. CAP water is available to a local water service organization, on a contractual basis, through the Central Arizona Water Conservancy District, which serves as a liaison with the Bureau of Reclamation. Water users may not freely transfer CAP water among themselves, although land with CAP water service contracts may be bought and sold. Subcontracts for agricultural CAP water may be converted to municipal and industrial water service subcontracts at the rate of 1 acre-foot per acre.[9]

A water user who wishes to acquire new or additional groundwater rights but for whom exempted groundwater rights or temporary groundwater permits are not feasible, may lease or purchase a GFR. Most permitted rights issued pursuant to the 1980 Code may be transferred, but they are usually only available for the same type of use. The major exception to this rule is the convertibility of an irrigation GFR to a Type I non-irrigation right. All transfers are subject to certain restrictions and must be approved by the Department of Water Resources. Temporary use permits may not be transferred.

Grandfathered irrigation rights are appurtenant to the land for which the right was granted and may not be severed from that land. The full amount of the water right is transferred with the ownership of the land. Grandfathered irrigation water may not be used for any purpose except irrigation and livestock watering. The water rights may only be used on the land for which the right was granted or on contiguous acreage under common ownership. The only exception to the strict appurtenancy rule for grandfathered irrigation rights is that a landowner may petition to substitute flood-damaged acres for other irrigation acres and transfer the water right.

Type I non-irrigation rights, or grandfathered irrigation rights that have been converted into Type I non-irrigation rights, are also strictly appurtenant to the land where the right originated. The full amount of the right is conveyed with the sale of the land. However, any quantity of water up to the limit of the right may be transported off the land to non-irrigation uses in other locations. Type I water may be transported within, between, or outside existing AMAs without liability or injunction.

If a Type I right has been converted from an irrigation right, the irrigated land must be permanently retired from irrigation. The number of acre-feet of water assigned to the Type I right is determined at the time of the conversion to non-irrigation use and remains fixed at that quantity for all future conveyances. Type I water may not be used for irrigation, and the right cannot be converted back to a grandfathered irrigation right.

Type II non-irrigation rights are the only groundwater rights not strictly appurtenant to a particular parcel of land. Within any given AMA, Type II rights may be freely transferred, subject only to legal regulations concerning the spacing of groundwater wells.[10]

Type II rights may not be used for irrigation, and are limited in the range of non-irrigation uses to which they may be put; rights designated for use in power generation or for mineral extraction are confined to those specific uses. Probably the greatest limitation on the transferability of a Type II right is its indivisibility; the law does not permit splitting Type II rights up into two or more smaller rights.

Effluent

In recent years treated sewage effluent has begun to receive increasing attention for its potential in conserving water through exchanges of potable for nonpotable supplies, satisfying Indian claims to water rights, recharging groundwater aquifers, and as a marketable resource.[11] Only small quantities of effluent have been bought and sold in Arizona to date, but management and marketing strategies are being discussed actively.

The legal status of effluent ownership, use, and transfer in Arizona is not yet clear. A major unresolved question concerns whether or not effluent is subject to regulation under state laws governing surface water appropriation and groundwater management.[12] A state court has declared that effluent is neither groundwater nor surface water and is not subject to existing state water law. If this decision is not reversed then effluent may be one of the most marketable water commodities in Arizona.

Water Market Activity

Water market activity in southern Arizona includes transactions involving Type I and Type II groundwater rights, adjudicated surface flows, and sewage effluent. One of the oldest water markets in Arizona is Tucson's ongoing acquisition of irrigated farmland in the Avra Valley, which lies about 15 miles to the west of the city. Tucson had contemplated developing water rights in the valley since at least the 1940s. The city acquired parcels of land and developed a wellfield and a transmission system to convey the water into the city in the mid-1960s. Transportation of Avra Valley water into the Tucson basin began in 1968.[13]

In 1971 Tucson began purchasing additional land in the Avra Valley in the vicinity of its wellfields. Over the 8-year period from 1971 to early 1979, Tucson acquired over 13,000 acres of irrigated land and brought farming to an end in the southern end of the Avra Valley. In 1979, when the passage of new water management legislation in the State was imminent, the Tucson city council called a moratorium on further land acquisitions until the legal status of their acquisitions could be clarified. Tucson ended the moratorium in 1984, and by the close of 1986 another 7,000 acres of farmland had been purchased and retired. The city expects to acquire the remaining 20,000 acres of privately owned irrigated land in the central and northern portions of the Avra Valley over the next 10 years.[14]

At the legal maximum of 3 acre-feet of water rights per grandfathered irrigated acre per year, Tucson's water right holdings in Avra Valley are in excess of 55,000 acre-feet per year. This is equal to nearly two-thirds of the annual level of water usage in the city. In recent years

Tucson has been pumping only between 5,000 and 6,000 acre-feet per year from the Avra Valley wellfields. Pumpage is expected to rise to over 15,000 acre-feet per year before the arrival of CAP water in the early 1990s. Pumpage will then decline to about 2,000 or 3,000 acre-feet per year, the minimum required to meet peak load demands on the city's water system. Importation of Avra Valley water is projected to increase again in future years as Tucson's population continues to increase.[14]

Prices for land purchased in Avra Valley have ranged between $1,000 and $2,000 per acre. Slightly more than 75% of the land Tucson has acquired in the Avra Valley has irrigation water rights. The city spends about $150,000 per year to reduce dust and weed problems on its retired farmlands,[13] in addition to the cost of aquiring land and water rights in the Avra Valley. If one assumes that the land and improvements have no value once the appurtenant irrigation rights have been retired for city use and that the transferable water rights average 3 acre-feet per acre of irrigated land per year, then current purchase prices for water rights range between $650 and $850 per acre-foot.

A second example of the acquisition of farmland for the conversion of grandfathered irrigation rights to Type I non-irrigation rights involves the city of Mesa, located in the Phoenix AMA. In the spring of 1985, Mesa purchased over 11,500 acres of irrigated farmland in fourteen separate transactions. The farmlands have irrigation GFRs which may be converted to Type I non-irrigation GFRs with a yield of over 30,000 acre-feet per year. They lie approximately 40 miles to the south of Mesa in neighboring Pinal County (Pinal AMA). Mesa intends to lease the land back to farmers for about 5 to 15 years, until the city is ready to develop the water rights for municipal use. The total cost of purchasing the 11,500 acres of land and 30,000 acre-feet of water rights was over $29 million. Prices ranged between $1,900 and $3,000 per acre, with an average price of about $2,600 per acre. Assuming the land has no value without the water rights, Mesa paid an average of about $1,000 per acre-foot.

If necessary, Mesa is willing to pipe the groundwater all the way to the city from the retired farmland. As a less costly alternative, however, Mesa is attempting to get approval from the Department of Water Resources for a plan to exchange groundwater for CAP water. Under this plan the city would pump Type I groundwater from the retired farmland into the CAP aqueduct, where it would then flow south to Tucson. In exchange, Mesa would pick up an equal quantity of CAP water (water meant originally for Tucson) out of the city's diversion point from the CAP aqueduct. Mesa does not yet have cost estimates for alternative proposals to deliver (or exchange) water to city users.[15]

The magnitude of Mesa's purchase has given rise to numerous concerns in Pinal County about the local economic impact of the farmland sales; primarily, the effect of the farmland sales on the tax base, and the loss of available water for development. Mesa hopes to allay these concerns by actively supporting the local community. In addition to the cost of purchasing the land and water rights, Mesa has committed itself to making "in lieu of taxes" payments to the two irrigation districts within which the farms are located. The city is also negotiating to keep the farmland's CAP allocation of 1 acre-foot of water per acre on the land for urban and industrial development.[16]

Type II non-irrigation grandfathered rights have been bought and sold in both the Phoenix and Tucson AMAs, where nearly all the Type II rights are concentrated. Most transfers of Type II rights have been part of real estate transactions involving land and improvements as well as water, and little can be inferred about the implicit market value of water rights in these sales. A few Type II rights have been acquired separately by individuals seeking to invest in water rights.[17] Some businesses have acquired Type II rights believing them to be cheaper means of getting water than hooking up to a municipal water system.[18] In 1985 and 1986, typical prices for Type II rights averaged $1,500 per acre-foot in the Phoenix AMA, and slightly over $1,000 per acre-foot in the Tucson AMA.

An emerging market for Type I and Type II water rights is the leasing of water in order to open new water service areas. Under Arizona law, the service area for a water service organization is not necessarily the same as the area within which it has the legal authority to provide service. The former consists of the area physically served with water. The latter is little more than a boundary line on a piece of paper, including the current water delivery area but conceivably extending far beyond it. Water service organizations can only withdraw groundwater from areas already within their current service areas. It is difficult for a water service organization, especially a new one, to provide new water service without already having the water resources on hand. A possible solution is to lease water rights just long enough to establish water service, and then to apply to the State for a service area groundwater extraction permit.[19]

Surface water rights are also being transferred in Arizona. In the spring of 1984 the city of Scottsdale purchased the Planet Ranch, an 8,400-acre ranch in western Arizona for $12.2 million. The source of water for the Planet Ranch is the Bill Williams River. Scottsdale hopes to divert water from the Bill Williams into the CAP aqueduct for transportation to the city.

Scottsdale has invested close to another $4 million in improving the ranch facilities and preparing land for irrigation. Ranch operating losses over the next few years are projected to total $1.5 million; the city expects to break even on operating costs in 1987.[20] Adjusting for inflation, the present value of the costs associated with acquiring the Planet Ranch water rights equals about $17.7 million. If the ranch does in fact yield 13,500 acre-feet of water as hoped, the cost for the water will be approximately $1,300 per acre-foot.

Inasmuch as the water rights for the Planet Ranch are appropriated rights and are subject to forfeiture if they are not put to beneficial use, Scottsdale will have to continue using them for agricultural purposes until they can be incorporated into the city's municipal water system. The precise quantity of water rights acquired in the purchase of the Planet Ranch and the proportion of those rights that may be removed from the river for transport

to Scottsdale have not yet been determined, although estimates place the quantity available for export at about 13,500 acre-feet per year. Aware of this uncertainty, Scottsdale included a clause in the purchase contract specifying adjustments in the ultimate sales price for the ranch should the water rights prove to be less than originally estimated.[20] If the water resources turn out to be less than expected quantity, the purchase agreement calls for a reduction in the sales price by $870 for each acre-foot of water less than 13,500.

Other recent acquisitions of land and water rights in western Arizona include the Lincoln Ranch and the Crowder-Weiser Ranches, purchased by private real estate developers, and farms in the McMullen Valley, purchased by the City of Phoenix. The 1,000-acre Lincoln Rand, located along the Bill Williams River upstream from Scottsdale's Planet Ranch, was purchased for approximately $5 million. The owner hopes to transfer between 7,000 and 7,500 acre-feet of water per year to the Phoenix area. Informal discussions have been carried out with the City of Scottsdale about sharing in the cost of building a canal from the Bill Williams River to the CAP aquaduct.[21]

The Crowder-Weiser Ranch, located near Vicksburg in La Paz County, is expected to yield over 51,000 acre feet per year. Crowder-Weiser was acquired in a series of transactions in 1985, at costs ranging from $500 to over $900 per acre-foot for the water rights. A minority interest in the Ranch subsequently was sold to a third party for about $1,200 per acre-foot. The water, which the developer hopes to deliver via the CAP aqueduct, will be used for projects in the Phoenix area.

In 1986 the City of Phoenix purchased 14,000 acres of farmland in the McMullen Valley in La Paz county for slightly over $30 million. The city expects to export up to 30,000 acre-feet of water annually from the land by the year 2005. Phoenix is hoping to use the CAP aquaduct to transport its water from the McMullen Valley to its service area.[22]

Sales of treated sewage effluent have occurred throughout central and southern Arizona. Pima County, in the Tucson AMA, has been selling up to 3,500 acre-feet per year of secondary treated sewage effluent to farmers in the Cortaro-Marana Irrigation District for several years at $5 per acre-foot. Recently the district agreed to an increase in the rental rate to $10 per acre foot. Tucson city policy now encourages all large commercial water users to purchase and use effluent to the greatest extent possible.[23] New golf courses are required to irrigate with effluent. Effluent charges for commercial water users in Tucson in 1986 were $372 per acre-foot.[24]

Another example of sewage effluent marketing is an agreement signed in 1973 between the Palo Verde nuclear power station and the cities of Tempe, Phoenix, Mesa, Tolleson, Scottsdale, and Youngtown—all in the Phoenix metropolitan area. The contract includes four separate purchase options, and if all are exercised, they would provide 140,000 acre-feet of effluent annually to cool the plant's reactors through the year 2040. The original price for the effluent was set at $30 per acre-foot, or 40% of municipal users' cost of CAP water, whichever is lower. A recent law suit challenging the agreement may force the contract to be revised.[12] If it is amended, the contracted price for the effluent could be increased to equal the cost of CAP water for cities, which now is expected to be at least $300 per acre-foot.[25]

To summarize, groundwater, surface water and effluent are being transferred through market transactions in Arizona. State laws that define and restrict water market opportunities vary considerably, depending on the type of water right under consideration. Water is steadily moving from irrigated agriculture to nonagricultural uses, and this trend will continue as rapid population growth continues in metropolitan areas.

SOUTHERN CALIFORNIA

Description of the Study Area

In California, as in many other Western states, water resources are concentrated in one part of the State while population, industry, and irrigated land is concentrated in another part of the State. Approximately 70% of the State's water supplies lie north of the latitude of Sacramento, while 80% of the State's population, along with most irrigated agriculture and industry, lies south of that latitude.[26, 27] A complex system of dams, reservoirs, and canals transports water south through California's San Joaquin Valley. The federal Central Valley Project (CVP), which began deliveries in 1951, extends to the southern end of the San Joaquin Valley. California appropriated funds for the State Water Project (SWP) in 1959, and the SWP's California Aqueduct transports water south through the San Joaquin Valley, over the Tehachapi Mountain range, and into the greater Los Angeles Metropolitan Area. Features of California's water infrastructure are shown in figure 3.

Southern California, defined as the region south of the Tehachapi Mountains, is characterized by a semiarid climate and a large concentrated population. Southern California has over 50% of the State's population and contains the nations's third largest metropolitan area, yet receives less than 3% of the State's surface water runoff. The southern part of the State imports more water than it produces locally.[28] The southern California water industry is dominated by public districts and municipal waterworks. The Metropolitan Water District (MWD) of Southern California services more than half the water users in the region. Over fifty reservoirs operate in southern California, managed by federal, state, city, and other water agencies. Irrigated agriculture continues to be an important part of southern California's economy, in spite of rapid urbanization of agricultural areas. Agriculture uses approximately 60% of the region's water supplies, and urban areas account for the other 40% of water use.[29]

Water Laws and Institutions

Approximately 55% of California's water supply is direct and stored surface water. Both riparian and ap-

propriated water rights are recognized under state law. While large quantities of water are used under riparian law, most of the surface water within the State is appropriated. Under an appropriative right, the user may divert allotted quantities of water from a particular source and location for a specific use, during a specific part of the year. Since 1914, appropriative rights have been created under a license system operated by the state. Appropriative rights are sometimes held by individuals or corporation, but they are much more commonly held by public entities organized for the purpose of supplying water such as the federal Central Valley Project (CVP), the California State Water Project (SWP), and local water districts. Agencies must obtain appropriative water rights before surface water development may be undertaken.[30]

Groundwater rights in California are typically associated with land ownership. Owners of land overlying a groundwater basin are entitled to pump water desired for use on that land. This is known as "overlying use." If the basin has water in excess of demand, that excess may be transported for use on nonoverlying land. The difference between current groundwater pumping and an aquifer's "safe yield" (the average annual recharge of the groundwater basin) determines whether that aquifer's groundwater may be used on nonoverlying sites. There are no statewide groundwater basin management statues. Court decisions have evolved the principle that groundwater overdraft can be reduced by mandatory limitations on pumping by each overlying owner, through a doctrine known as "mutual prescription."[31]

The California Department of Water Resources (DWR) was created by statue in 1956 to take the responsibility for all matters pertaining to water and dams. In 1967, the legislature merged the functions of the State Water Rights Board and the State Water Quality Control Board into the State Water Resources Control Board (SWRCB), which has jurisdiction over the nine regional water quality control boards. The SWRCB focuses on three distinct areas—water quality, water rights, and planning and research. The board has grown in stature and authority along with the growing concern for environmental issues in the State. The board acts in a quasi-judicial role in determining rights to surface water. Of particular concern to the board when making water rights determinations is the prevention of waste and unreasonable use of water.

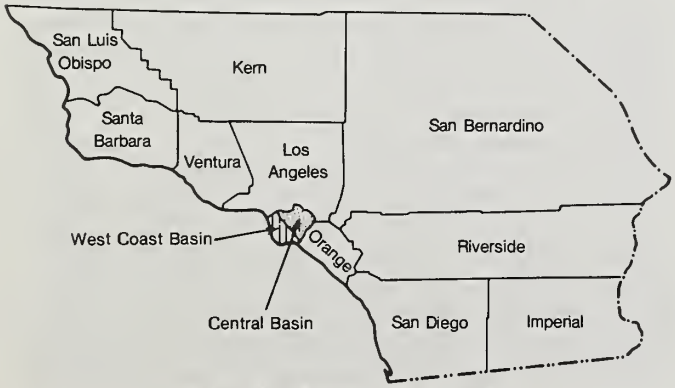

Figure 3.—Southern California.

California's water is allocated to its user, for the most part, through a hierarchy of government agencies. California water supply agencies are characterized by a wide diversity of scale and a variety of legal forms. Long-standing commercial water companies and mutual water agencies number in the hundreds. Their principal purposes are to establish rights to water use and to sell and deliver water to users. Mutual agencies sell water to members at supply costs and are thus nonprofit. Water companies sell water to customers within their service area at whatever prices the market will bear, and the profits are distributed to stockholders as with any other private company. It is not known how much water is allocated by these private entities, but mutual companies are more frequently utilized in irrigation, whereas commercial companies are more heavily involved in serving urban customers.

A wide array of private and public institutions exist for the purpose of developing and allocating water resources, employing operating rules established by enabling legislation. These rules largely determine the distribution of economic rents connected with water use and influence the efficiency of water development and allocation. More than 3,000 different organizations supply water in the State, of which nearly 1,000 are public water districts. About 900 of these public districts were formed under 40 general water district acts; the remainder were individually created by the Legislature by special acts.[32]

The public water districts that supply most of the water to agriculture are reclamation districts, irrigation districts, and water districts. Their primary purposes are to reclaim and protect lands from overflow and to irrigate lands. These public districts are, in essence, nonprofit wholesalers of water. They may have water supply sources of their own, both surface water and groundwater, or they may contract for water developed by the federal government (the Central Valley Project) or by the State of California (the State Water Project). They are governed by boards of directors, may have powers of eminent domain, and have the power to sell general obligation bonds, levy water charges, and impose ad valorem taxes on landowners within the district. Most water service agencies function under appropriative water rights laws. Riparian users are typically small, and take water only for their own use.

The agencies and individuals participating in the water allocation system in California can be stratified into four levels. First are the courts and the State Water Resources Control Board; next are the federal and state water supply agencies; then come the regional and local water agencies. Water users comprise the lowest level of the hierarchy, but in many instances they are the holders of water rights. While much of the developed water initially was allocated through the federal and state water projects, some goes directly to regional and local water districts, and some goes directly to users.[28]

Uncertainty over transferability of water rights makes water users reluctant to consider selling or leasing their water rights. Until recently, one of the biggest legal impediments to water transfers has been the "beneficial use" doctrine, which limits all water rights to an amount

"reasonably required for . . . [a] beneficial use." While originally enacted as part of the California constitution of 1928 in an attempt to discourage the wasteful use of water, this doctrine actually inhibited voluntary reallocation of existing allotments to parties who could make better use of the water.[30] In 1982, the state legislature took steps to clear this legal obstacle to transfer by enacting a law permitting the sale or lease of water deemed "surplus" to a user's needs.[33]

In California, riparian surface water use and overlying groundwater use are legally defined on the basis of land ownership—the rights to use such water cannot be transferred independent of the land title itself. Hence, purchasing a piece of land with either riparian or overlying groundwater rights is akin to purchasing the land plus an option to use water on that land subject to its availability, to requirements for reasonable and beneficial use, and other restrictions discussed earlier.

The state Water Code, as amended in 1971, prohibits districts from transferring water to outsiders unless it is declared "surplus." The test of "surplus" is strict and can rarely be met, apparently requiring the water to be unusable, at any price, by any member of the district. The enabling acts of many water districts do not provide for reallocation of water from one member to another once an initial allocation is made. Furthermore, as a general rule, riparian rights cannot be transferred for use on nonriparian land.

Appropriative rights are legally transferable, and can be sold, independent of title to land. They are the easiest water rights to transfer because the water right is recorded and the legislature has established procedures for transferring appropriative rights. The transferer must comply with the applicable provisions of water law governing a change in the purpose of use, place of use, and point of diversion. The Water Board may approve a transfer if it is in the public interest and there is no injury to other water users. In instances where the possibility for injury to other users is unknown, the board may authorize a trial transfer not to exceed one year in order to judge the effect of the transfer. The board may modify or revoke the trail transfer if it determines that the transfer will result in substantial injury to any water user. However, the occasions on which transfers actually occur are limited and always subject to the uncertainty of SWRCB approval. Appropriative groundwater rights are relatively uncontrolled, except when a groundwater basin becomes overdrawn, at which time overlying groundwater users have priority, and appropriative groundwater rights can become worthless.

Groundwater in adjudicated groundwater basins may be transferred only after a determination of the amount needed for reasonable beneficial use on overlying lands reveals that a surplus exists. The surplus may be appropriated for export. Surplus waters cannot be exported from the area if this will result in injury to other overlying owners.

Water Market Activity

The current system for defining and managing water rights in California presents obstacles to market allocation of water. Individual water users often do not own the water rights themselves—the water companies or districts do. In California, the Bureau of Reclamation and the Department of Water Resources are permittees of the State Water Resources Control Board, which has ultimate jurisdiction over water rights. Contractors of these agencies technically do not hold any permanent water rights beyond their contracts. They are given options to purchase water from the districts on terms specified in the contract. The district, which is bound by contract to supply water, isn't free to negotiate the sales of water rights or even water rentals unless it has surplus water available. In the case of State Water Project water, any changes in contracts or in points of diversion must be approved by the director of the Department of Water Resources. This type of administrative approval is likely to be difficult to obtain. The ultimate water users are powerless to make any transfers at all. The most they can do is simply forfeit their use of water, but usually they are committed by contract to take a certain amount. The result is an inflexible and inefficient water allocation system.

Options to buy State Water Project water are generally not transactable. They cannot be bought, sold, or leased without approval of the SWP. A series of water transfers took place within California during the 1976–77 drought, all under special circumstances. Nearly all of the transfers occurred outside of the SWRCB appropriations system, and with few exceptions, the water was sold by individuals or corporations with clear title to the water rights, rather than by a water district. These sales tended to be short-term leases negotiated in response to drought conditions.[32]

Many of the transfers that occurred were within the Bureau of Reclamation's Central Valley Project. The Emergency Drought Act of 1977 granted the Secretary of the Interior the authority to establish a temporary water program for the purpose of minimizing agricultural losses resulting from the drought. During the program's period the Bureau purchased 46,438 acre-feet of water at prices ranging between $20 and $87 per acre-foot. The Bureau resold 42,533 acre-feet of water to various buyers at a price of $53 an acre-foot plus conveyance charges.[34]

The Bureau administratively determined the purchase and sales prices of the water. Under the act the purchase price could "not confer any undue benefit or profit to any person or persons compared to what should have been realized if the water had been used in the normal irrigation of crops adapted to the area." The Bureau negotiated the purchase price by considering the seller's net income adjusted by certain handling costs. Resale prices were restricted to cover the actual expenditure involved in acquiring and redistributing the water. Thus, the program rationed water allocation through a buyer preference system and marketed water simply at cost.[34]

Water exchanges and transfers take place routinely in Central and West Coast Basins of Los Angeles County. These basins were adjudicated in the early 1960s and groundwater use is administered by the Department of Water Resources, which serves as court-appointed

Watermaster. Both basins participate in groundwater replenishment programs, sea water barrier projects, and water quality and groundwater level monitoring. The Watermaster administers an Exchange Pool, which facilitates transfer of water from water users who will not use their entire allotment to water users who desire water in excess of their current allotment. The price charged for Exchange Pool rights is based on a formula specified in the adjudication court orders, not on negotiation between water users. In 1985 the Exchange Pool price was $184.29 per acre-foot in the Central Basin and $69.54 in the West Coast Basin.[35]

The Exchange Pool is not the only method of obtaining additional pumping rights. Water users may freely buy, sell, and lease groundwater rights within each basin. In the Central Basin, water rights sales over the past two decades have served to concentrate groundwater rights ownership, reducing rights holders from 508 in 1966 to 194 in 1985. Sales and leases are recorded with the Watermaster. Summary price information shows a steady rise in average leasing prices from $50 to more than $90 per acre-foot over the period 1964 to 1985. Privately negotiated leasing rates lie 20% to 30% below the Exchange Pool rates and are up to 50% less than Metropolitan Water District's rates per acre-foot. Pumping rights are viewed as a commodity in Los Angeles County. Pumping rights, including leases, are taxed as property rights by the County.[35]

Wahl and Davis[36] note that substantial economic incentives exist for water transfers between the federal CVP and the SWP, both of which move water south through California's San Joaquin Valley. In particular they argue that farmers in the Westlands Water District, who are confronted with the water quality impacts of agricultural drainage on Kesterson Reservoir, would be willing to sell land and water rights to the State Water Project for prices that lie below the costs of SWP's least expensive supply development alternatives. While clear economic incentives for the transfer exist, the author point out that unresolved legal questions remain a barrier to CVP-SWP transfers, as do the high transaction costs of multi-agency cooperation and negotiation.

Southern California's Metropolitan Water District has been engaging in complex negotiations with Imperial Irrigation District (IID) for transfer of conserved water for IID to MWD. MWD proposes to finance conservation measures within IID in exchange for rights to use conserved water. The average cost per acre-foot for 400,000 acre-feet of conservation investments is $240 per acre-foot conserved. This represents an economically attractive source of water, relative to MWD's other supply enhancement alternatives. However, negotiations have proved complicated because of legal uncertainties, federal and state agency concerns over the proposal, and MWD and IID concerns over security of rights transferred and terms of transfer.[36]

MWD is also investigating the possibility of receiving federal CVP water in drought years in return for MWD assistance in constructing distribution systems for a San Joaquin Valley Water District and for MWD provision of SWP water to that district during wet years. This proposal is in the early stages of negotiation.[37]

There is increasing pressure in California to permit development of water markets. It is the established policy of the State of California to encourage the voluntary transfer of water and water rights. The legislature has specifically stated that transfer of water or water rights does not, in itself, constitute evidence of waste or unreasonable use. Recent California legislation permits water to be transferred if the water use has been reduced or discontinued because of the substitute use of reclaimed or waste water. Additionally, the law now permits the transfer of appropriated water and an appropriative water right if the use has been discontinued or reduced because of water conservation efforts. These transfers must be undertaken pursuant to the provisions of laws governing transfers. Under other legislation passed in 1982, any regional or local public agency authorized to serve water may not transfer surplus appropriated water to users outside its boundaries. Any appropriated water may be transferred if the agency and individual water users and right holders agree. Given these developments market transfers of water in California are likely to become increasingly common.

NORTHEASTERN AND SOUTHEASTERN COLORADO

Description of the Study Area

The market areas chosen for study in Colorado are the Northern Colorado Water Conservancy District (NCWCD) and the Southeastern Colorado Water Conservancy District (SCWCD). The NCWCD includes irrigated and dryland farming areas, town, and cities in the South Platte River basin. The principal metropolitan centers included in the district are the cities of Boulder, Fort Collins, Greeley, Longmont, and Loveland. The SCWCD includes irrigated and dryland farming areas, towns, and cities in the Arkansas River basin. The principal metropolitan centers included in the district are the cities of Pueblo, Fountain, and Colorado Springs. Another city located outside the SCWCD in the Denver area, Aurora, has successfully transferred water out of the Arkansas basin and is currently attempting to purchase and transfer additional water rights out of the basin. Aurora is therefore included in the discussion of SCWCD water transfers. The areas are shown in figure 4.

The predominant source of water in both market areas is mountain stream runoff. The natural supply of surface water is supplemented with transmountain diversion projects and with groundwater pumping during periods of peak demand. Transmountain diversion water and most native stream water are of high quality, except for flows in the lower reaches of the Arkansas where salinity levels are significant.[38] Groundwater quality varies depending on location, but is generally poorer than that of surface flows.

Nearly all native water supplies appropriated for use below (east of) the front range of the Rocky Mountains are controlled by mutual stock irrigation companies, privately held irrigation companies, rural-domestic water districts, or municipal water service organizations. Some

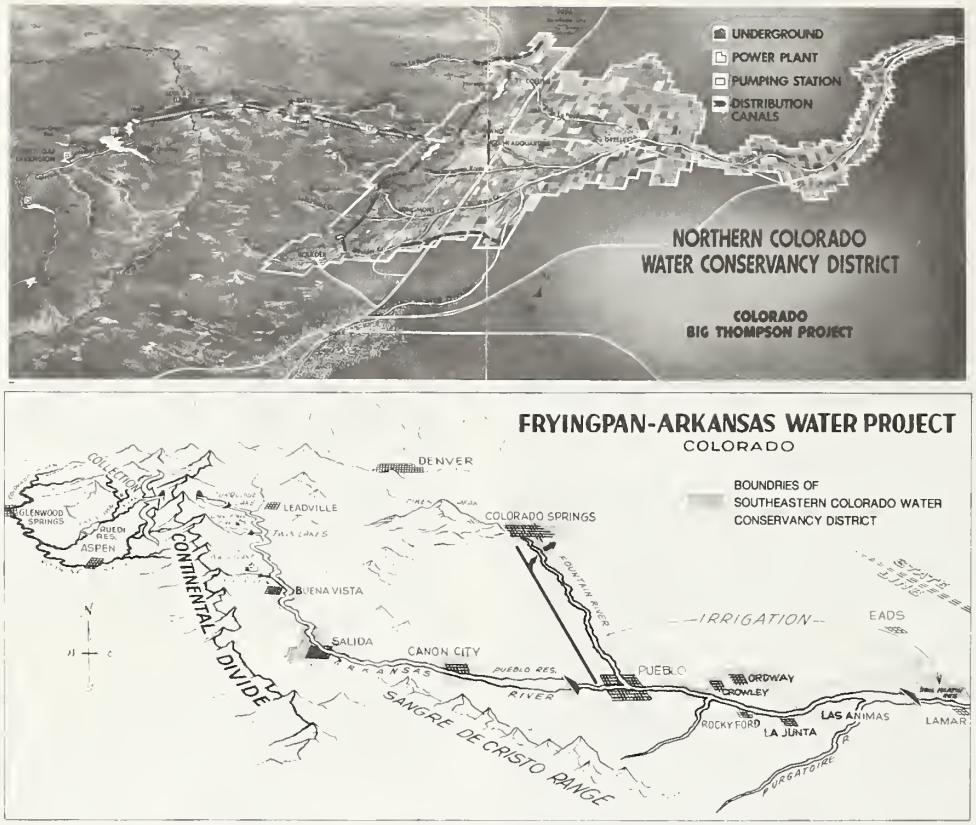

Figure 4.—Northeastern and Southeastern Colorado.

native water mapflows, especially in the upper reaches of the Arkansas River, are still held under individual appropriation decrees.

There are two major transmountain diversion projects in the NCWCD, the Colorado-Big Thompson Project (C-BT) and the Windy Gap Project. The C-BT was the first and largest transmountain diversion project in Colorado. Built by the Bureau of Reclamation in the late 1950s, the C-BT delivers up to 310,000 acre-feet of water per year to agricultural and municipal and industrial users throughout its service area.[39] The locally financed and newly completed Windy Gap Project, which began deliveries in 1985, promises to furnish primary rights to an additional 48,000 acre-feet of water for municipal and industrial users in the area. Return flows from the Windy Gap Project will be transferred to other water using entities for a variety of purposes including irrigation, domestic use, and groundwater recharge.[40]

More than a dozen transmountain diversion projects have been constructed to serve the Arkansas River basin, although none approaches the size of the C-BT. Most of the projects are owned in their entirety by individual municipal water service organizations. The two major exceptions are the Twin Lakes and Frying Pan-Arkansas (Fry-Ark) Projects, which were constructed by the Bureau of Reclamation. The Fry-Ark Project, managed by the Southeastern Colorado Water Conservancy District, is the largest transmountain diversion works in the Arkansas River basin. The Fry-Ark delivers approximately 80,000 acre-feet of water to agricultural, municipal, and industrial users in the SCWCD. About 70% of the water comes from transmountain diversion, while the remaining 30% is developed from "storable flood waters" of the Arkansas River and its tributaries.[41]

The Twin Lakes Project is an enlargement of the old Twin Lakes Reservoir and Canal Company system, which originally handled only native flow waters but is now primarily a transmountain diversion project. The system is partly owned by the Federal Government and partly by the Twin Lakes Reservoir and Canal Company. The shares of mutual stock that may be bought and sold on the market represent only that portion of the water in the reservoir controlled by the private water company. All remaining storage space in the reservoir is used to support the Frying Pan-Arkansas project. Roughly 10% of the total average annual yield of Twin Lakes stock is attributed to native flow while the rest represents transmountain diversion water rights deeded to the company by the Bureau of Reclamation.[42] About 50,000 acre-feet of water per year are delivered to Twin Lakes company stockholders. Originally all of the water was controlled by irrigators, but now the company is almost completely owned by the cities of Aurora, Colorado Springs, Pueblo, and Pueblo West.[43]

The water service infrastructure within the NCWCD is much more integrated and extensive than that within the SCWCD. The system of capturing, storing, and distributing water resources in the NCWCD constitutes one of the most complex and flexible water supply networks in the Western United States. Dozens of different water service organizations operate hundreds of miles of canals, storage, reservoirs, pumping facilities, and water treatment plants serving an area roughly equal in

size to the State of Connecticut. Conditions are much different in the Arkansas River basin. Whereas population, water resources, and economic activity are distributed throughout the upper South Platte basin, they are relatively concentrated in the Arkansas basin along the base of the front range, in the Fountain Valley (a tributary to the Arkansas) and along the narrow band of the Arkansas River itself. Water storage and delivery facilities are less developed, and the opportunities for exchanging water among different organizations are correspondingly less.

Irrigated agriculture is the predominant water user in both market areas. However, rapid urban expansion in every metropolitan center throughout the NCWCD has caused irrigated land to be retired and developed. Growth has brought pressure to transfer water rights out of irrigation to municipal uses. The process has been gradual and continuous in the NCWCD, while it has been uneven and sometimes abortive in the SCWCD.

The geographical locations of water resources, population centers, and economic activity in each of the two areas have had a strong influence over the nature of the water markets. In the NCWCD, the newer nonagricultural water users are intermingled with older agricultural users. Expanding urban developments often acquire additional water rights by expanding onto previously irrigated farmland. Hence, urban development tends to replace irrigated agriculture in the NCWCD in a smooth and orderly transition.

In contrast to the relatively unencumbered transfers of water rights experienced in the Platte River basin, transfers in the Arkansas River basin have been complex and difficult. The main centers of population growth and new economic activity in the SCWCD are clustered about the centers of Pueblo, Colorado Springs, and Fountain (and Aurora), which are located upstream from most existing water users. Transferring water rights from the old water users to the new ones does not involve a simple change of use within the same general area. Water rights must instead be transferred over long geographical distances and across jurisdictional boundaries. Conflicts over water transfers are common. New water development projects in recent years have provided costly but practical alternatives to the uncertainties and difficulties involved in water rights transfers.

Water Laws and Institutions

Water rights in Colorado have been subject to the legal doctrine of prior appropriation since statehood was declared in 1876. All groundwater and surface water rights must be put to beneficial use or risk forfeiture.[44]

Surface Water Rights

Surface water rights in Colorado are of two different types—streamflow and reservoir rights. Appropriated stream flows are generally quantified in terms of flow rates and priority dates. Appropriators may withdraw water from the stream at specified maximum flow rates (cubic feet per second) so long as the flow rate in the stream itself is at or above some specified minimum level. The more recent the priority date, the higher is the minimum streamflow rate required to activate the right. In contrast, reservoir rights are specified in terms of acre-feet of volume. During any given year the most senior reservoir right holders may fill their reservoir(s) to the capacity of their right first, followed by the next most senior right. Reservoir rights are usually activated in periods of high streamflow (winter and spring runoff) before the beginning of the irrigation season.[45]

Reservoir rights in Colorado are extremely important. Most stream systems in Colorado are highly variable, alternating between periods of flood and drought. Without a means of regulating water supplies, appropriators in Colorado could not expect to have reasonably secure water supplies unless they held very senior water right and/or a quantity of rights disproportionate to their average use patterns. Storage facilities can also increase the effective volume and thereby the value of a water right. They allow users to regulate the timing and volume of releases to conform to their patterns of use with minimal waste. Supply fluctuations can be smoothed out and waste minimized by storing unused water during periods of high water flow and releasing them for use when natural water flows are low.

Another important advantage of having access to water storage facilities in Colorado is that they facilitate water exchanges—one important means of optimizing the use of water resources and water rights that are unevenly distributed over time and space among two or more water users. A good example of a water exchange that necessitates the use of reservoir space is an arrangement the city of Colorado Springs has recently developed and which is still pending final approval in water court. Historically, Colorado Springs had released its treated effluent into the Fountain River, where it provided a windfall gain to downstream appropriators in the Fountain and Arkansas River systems. Now the city exchanges a portion of its return flow with a compensating quantity of water in Pueblo Reservoir (located upstream from the confluence of the Fountain and Arkansas Rivers), and then exchanges this water further upstream for its mountain reservoirs. From these reservoirs Colorado Springs is able to draw the water to the city through its existing conveyance system. Although there have been protests from downstream appropriators who claim that Colorado Springs forfeited the right to recapture its return flows after years of nonuse, the city is confident that eventually its right to the exchange will be affirmed.

Water rights transfers in Colorado are often complicated by the fact that both flow rights and storage rights may change hands in a transaction. Because of the flexible nature of storage rights, their market value may reflect far more than the value of the water that could be impounded in a single filling of the right. It is not unusual for a buyer to acquire a package of water rights primarily for the purpose of gaining additional storage capacity and only incidentally to increase its inventory of water rights.

Storage rights may increase the value and usefulness of several different water rights through allowing the rights holder to capture, store, and/or exchange quantities of water several times over the course of a single season. The storage right itself is valid for only a single filling of a reservoir per year. Once the water right is used, however, the storage space may still be available for other purposes. Users may refill their space in a reservoir with exchange water or stored water that they have under other flow decrees. Tourquoise, Spinney Mountain, and Twin Lakes reservoirs all serve this latter purpose for the cities of Colorado Springs and Aurora. The storage space available in these reservoirs form essential links in bringing water from many scattered flow rights into the cities.

Groundwater Rights

The application of the appropriation doctrine to groundwater rights has been a slow and uncertain process. The classic distinction made in most states between "percolating" groundwaters and those in "definite streams or channels" has not been important. Distinctions of greater legal significance are found between groundwaters that are tributary to a surface watercourse and those that are not. Little legislative action is found concerning groundwater in the early history of Colorado because groundwater supplies were not extensively developed until fairly recently. For most of the State's history, groundwater wells have been allowed to develop as if they took water from a source of supply entirely separate from the surface water streams. It was inevitable that as more and more groundwater resources were developed, the effects would begin to be felt on surface water flows.[46]

Since most existing groundwater appropriations are junior to most surface water appropriations in use, both the Arkansas and Platte River basins are now closed to additional groundwater appropriation. Those groundwater resources that are judged to be tributary to a surface water flow are limited in the number of days of the month that they can operate. If groundwater users wish to pump beyond the legal limit, they are required to file an approved "augmentation plan" with the State. Alternative means of augmenting stream flows affected by groundwater pumping include acquiring and then retiring stream flow rights, releasing stored water into streams, or purchasing another water user's return flow for release into streams.[47]

Appropriation decrees for water rights in Colorado provide no volumetric limitation on the extent of a right. State law prohibits the wasteful use of water, but does not specify what constitutes waste. For land to be irrigated in Colorado, it must either have an original appropriation of water rights appurtenant to the land, or have existing water rights transferred to the land, or be included within the service area of a water company that supplies irrigation water. Irrigation water rights may be supplemented by renting additional water for any length of time desired.[47]

Under Colorado law, the appropriative right to water is a property right separate from the land to which the right is appurtenant. Hence, the land for which a water right was appropriated or the water right itself may be transferred in part or in its entirety independent of one another. Water rights may be freely bought, sold, or rented as a general rule. However, if the transfer of a water right involves anything more than a change in ownership, the state must ensure that no other existing water rights users will suffer injury. If the only change in a water right is a change in ownership, there is no limitation on the right to transfer and no approval is required by the State. Conveyance of a water right separate from the land, however, or any proposed change in the point of diversion or place or purpose of use, is monitored strictly to protect the rights of all junior and senior appropriators on the particular stream system.[48]

The state Supreme Court appoints a Water Judge for each of the seven administrative water districts in Colorado. In the judicial process in Colorado, the district water courts play the primary role in determining water appropriations, and the merits of an anticipated transfer of water rights. Colorado law specifies that to make a change in point of diversion or place or purpose of use of a water right one must bring suit in a district water court. The purpose of this litigation is to allow the court to hear all protests to the transfer so that no person with alleged property rights in the area affected by the water transfer will be injuriously affected. Change applications are generally approved if it can be demonstrated to the satisfaction of the Water Judge that the change will not adversely impact third parties. Changes might still be allowed in the face of third-party effects if the presumed injuries can be appropriately mitigated or compensated.

Water rights transfers are often difficult in Colorado. The major problem is the uncertainty with regard to how the water rights will be quantitatively defined by the courts. Courts must consider multiple users of water associated with a given set of appropriations and related return flow patterns. Return flows give rise to subsequent sets of secondary appropriations that vary with the availability of water as determined by return flow, storage facilities, groundwater sources, precipitation, and other factors.[49] Furthermore, there are no predetermined measures of consumptive water use for specific economic activities or by geographical locations. The water court must decide on an ad hoc basis the net impact on a stream system of a particular appropriation, and then deduce from available information the average consumptive use of water from this appropriation. Generally, it is the consumptive use portion of the water right (i.e., the net quantity of water historically removed from the system under the existing appropriation) that is judged by the water court to be the quantity transferable to a new location and use.

Water rights transfers are further complicated by the adversarial nature of water court proceedings. Since the State Engineer is not consulted on proposed water rights transfers, the courts call for engineering reports from each of the contesting parties. Both the petitioners for the water rights transfer and the protestants are called upon to support their contentions relating to the transfer. The court must make a choice or a compromise between conflicting testimonies, without the benefit of unbiased

and objective professional engineering skills and information.

In spite of these obstacles, water transfers are common in Colorado, primarily owing to the existence of a number of institutions, statutes and water court rulings that can simplify the water transfer process by reducing or eliminating the legal claims of opposing parties. For instance, water in one hydrologic basin may be appropriated and "exported" or transferred for use in other hydrologic basins. Once the transbasin diversion of water is accomplished, users of "imported" or "foreign" water do not have the return flow obligations that users of "native" flows have to other appropriators in the same area. Holders of imported water rights may transfer their water rights to any user within the decreed area of use for the water right without liability. Court proceedings are necessary only if an owner of transmountain water rights wishes to transfer water out of the original area of use, or use it for a purpose of use not specified in the appropriation decree.

Imported Water Rights

Holders of imported water rights have dominion over the entire right. They may use and reuse and/or sell the water to extinction (total consumption), so long as the water can be identified. Suppose, for example, that a water user owns 100 acre-feet of transmountain diversion water and can demonstrate to the satisfaction of the water court that 70% of the water it uses returns to the stream system. The user may then develop the right to reuse or sell the 70 acre-feet. Suppose it sells the 70 acre-feet of return flow rights to an irrigation company downstream, which in turn can demonstrate that 30% of its use is return flow. The company may therefore in turn either recapture 21 acre-feet or sell it to yet another water user, and so on until the water is either abandoned or totally consumed within the system.

District water courts in the areas of the NCWCD and SCWCD have handed down opinions that essentially give transferred native flow rights the same legal status regarding the returning return flows as imported waters. Because only the consumptive use portion of a native flow right is transferred, and that portion is by definition the quantity of water historically lost to the system, it may be presumed that no appropriators to native stream flows have any claim to the water. Rights to native flow waters that have already been transferred are therefore rights to the entire measure of the right, and may be used, reused, and/or sold to extinction. Although the implications of the rulings of these courts have not yet seen widespread application in Colorado, they may have a significant impact on the future transfer and management of water rights.[42]

Water Companies

Water companies typically control a "bundle" of different water rights, including decreed native flow rights, reservoir rights, and transmountain diversion water.[50] The significance of company ownership of water rights is that the water is appurtenant to the company's service area as a whole and not to any specific parcel of land. All water rights managed within the company service area are legally recognized as having the same point or points of diversion (the company diversion works) and the same place of use (the company service area).

Individual water users in the company service area own a proportional interest in the company, most often represented by shares of stock. Dividends in the form of water allotments are declared on the basis of stock ownership rather than on land ownership. The size of the allotment varies from season to season in accordance with the hydrologic cycles of the system, but the long-term average yield and the variability of water service per share of stock generally is well known. The water stock, and the water service represented by that stock, is legally considered personal property that can be bought, sold, or rented for any desired length of time within the company service area, without the need for proceedings before the district water court. Transfers of water company stock require proceedings before the water courts under only two circumstances—if the contemplated transfer includes a change in the purpose of use or if the stockholder wished to transfer water outside the company service area.

Twin Lakes Reservoir and Canal Company water is marketed in the same fashion as any other mutual water stock. The only difference is that a small portion of the water rights held by the company are recognized as native flow rights, while the rest are transmountain diversion water rights. In the early 1970s the city of Aurora purchased some Twin Lakes stock, but secured a court decree to transfer only the transmountain portion of the water rights to the city, located in the South Platte basin. Before the city could transfer the native flow portion of its Twin Lakes water rights as well, the district water court would have to determine the transferable (consumptive use) portion of the native flow component of the water rights. The yield on Twin Lakes stock held by Aurora averages slightly less than the yield on other shares of Twin Lakes stock held by other parties who retain the stock within the South Platte basin and have access to both the transmountain and native flow portions of Twin Lakes water.[42]

Public Project Water

Mechanisms and procedures for managing public project water can vary substantially within Colorado. The Fry-Ark and C-BT were both conceived as multipurpose projects to supply supplemental water to existing irrigated lands and growing urban centers. The means of allocating water under each project to its users, however, are very different.

Shortly after its creation in the late 1950s, the governing board of directors of the SCWCD decided that the allocation of Fry-Ark water would be fixed at 51% for municipal and industrial use and 49% for irrigation. The allocation may be changed by the board in the future to

reflect conversion of agricultural lands to nonagricultural use. Users of Fry-Ark water who transfer any or all of their other water rights to other users do not have the privilege of replacing these rights with Fry-Ark water.[41]

Each year the board makes a determination of how much water will be available for distribution to eligible project beneficiaries. It then contracts with each individual water user or water service organization in the conservancy district that wishes to buy the water. Nobody is required to buy project water. The unit price for Fry-Ark water is predetermined by the board and is the same for all users. The governing board of the SCWCD exercises dominion over both the first rights to Fry-Ark water and to its return flows. No user has the right to sell project water available for delivery in any given year. Return flows are sold by the SCWCD for the same price as primary use water ($8 per acre-foot)[51]. They are available only to those individuals or water service organization who are eligible to purchase Fry-Ark water. Most return flows are purchased by groundwater users in the district to meet state requirements for groundwater augmentation.

The Fry-Ark system of water allocation offers water storage programs for its users in order to use their decreed flow rights more efficiently. Users are allowed to store any unused quantities of their Fry-Ark water in project storage facilities. Agricultural users may hold their unused water until May 1 of the following year, while municipal and industrial users may carry their unused water over from year to year.[51] The carryover program is limited by project reservoir space. SCWCD also allows agricultural users to store their own (nonproject) decreed native flow rights during the winter season for use in the summer.[52] Whereas decreed flow rights in other areas of Colorado sometimes specify a particular season of use for the right (typically April 1 to October 1), most direct flow rights in the Arkansas River basin are active all 12 months of the year. Large quantities of water that previously had to be released downstream unused may now be captured and stored in Pueblo Reservoir for later use. The District charges $3.20 per acre-foot of water stored, and the water may be stored until May 1 of the following year. Under the Winter Storage Program several cities and towns that have storage rights in their own privately owned reservoirs may also retain their direct flow rights for use later.

The C-BT project differs in a number of important respects from the Fry-Ark. Water allocated under the C-BT project was deeded directly to the individuals and the water service organizations within the project service area who expressed an interest in participating. The NCWCD retains all rights to the return flows of project water, but each water user has the full right to purchase, sell, trade, or rent rights to the primary flows.[53] Return flows from the C-BT may be neither recaptured nor resold by C-BT users. Return flows that are not allocated by the NCWCD to its users simply remain in the river. The effect has been to firm up the water supply available under native flow appropriations on the lower reaches of the South Platte. Water users at the downstream end of the NCWCD have found little advantage in holding on to shares in a project that effectively provides them with water whether they participate directly in the project or not. Most downstream appropriators have sold most, if not all of their C-BT rights to upstream users.[54] Unlike the Fry-Ark, the C-BT System does not allow carry-over or storage privileges.[53]

The water rights to the C-BT are represented by 310,000 shares, or units. An annual fee to cover the fixed and operating costs of the project are assessed on each unit owned. The vast majority of C-BT units are held either by individuals for the purpose of irrigation, or by municipal or domestic water service organizations. A smaller number of miscellaneous units are held by collective irrigation organizations, nontaxable entities, and manufacturing concerns.[55] Generally the only restriction on the ownership of C-BT units by individuals is that the units must be assigned (appurtenant to) a parcel of irrigable land. The NCWCD discourages excessive speculation in C-BT water by limiting the ownership of project units to only that quantity that may be put to beneficial use on the property or within the service area to which it is assigned. As a hedge against future growth and also against supply fluctuations, municipal and rural water service organizations are permitted to hold rights in excess of current use.

The Windy Gap Project was planned, organized, and funded locally by the cities of Boulder, Estes Park, Fort Collins, Greeley, Longmont, and Loveland. Since the project's inception, Fort Collins has transferred its direct interest in the project to the Platte River Power Authority, and Estes Park has sold part of its interest to the city of Broomfield and to the Central Weld County Water District. Each participant in the Windy Gap Project assumes a proportionate share of the responsibility for the project costs, and in return has the right to a proportionate share of the water supply available for delivery through the project. Owners of Windy Gap water can use the primary flow and then reuse or sell the return flow to extinction, as long as it can be identified. The service area for the Windy Gap Project, that is, the area within which Windy Gap primary and return flow rights can be used and/or marketed, includes all of the NCWCD and some additional areas to the south.

Water Market Activity

Water markets in northeastern and southeastern Colorado differ greatly in both the frequency and nature of activity, and in the degree of access that the various users have to the market. In northeastern Colorado, willing buyers and sellers are often within the same water company service area, while those in southeastern Colorado usually are not. Users in northeastern Colorado usually can transfer water rights simply by signing a stock certificate, but in southeastern Colorado nearly any major transfer requires formal water court proceedings to change the point of diversion and place of use of the water rights to new locations.

Northeastern Colorado

Northeastern Colorado has a very favorable institutional environment for allowing the transfer of large quantities of water rights over wide geographical areas. The single largest source of water in the area, the C-BT, is also the easiest type of water to transfer. The only source of water in southeastern Colorado that has been marketed freely over a wide area, Twin Lakes, represents a small portion of the total available water resources available to users in the Arkansas basin. Furthermore, these water rights are now almost impossible to buy. When Twin Lakes stock came on the open market for nonirrigation use several years ago, almost all of it was purchased quickly by a few large users. Since then, virtually no shares of Twin Lakes stock have been offered on the market.

Although water rights transfers have been observed in northeastern Colorado for many years, the existing market began to assume its present characteristics with the completion of the C-BT project in the last 1950s. From the beginning, the project was intended to provide water to agriculture, private homes, and commercial businesses in varying proportions over time. In order to ease the transfer of water rights from irrigation to nonirrigation use, the appropriation decree permitting the transfer of water from the West to the East slope stipulated that C-BT water could be used for either irrigation or non-irrigation purposes. Municipal water service organizations and rural-domestic water companies have therefore been able to acquire C-BT units from irrigators without applying to the water courts for the right to change its point of diversion, place of use, or purpose of use. Moreover, they are free, wherever they choose, to rent any portion of their unused C-BT water back to irrigation users without obtaining special authorization.[56]

When the 310,000 units of the Colorado-Big Thompson Project were distributed by the NCWCD to project participants in the 1950s, nearly 85% were assigned to agriculture. The remaining 15% assigned to other uses was adequate to meet virtually all nonagricultural demands for C-BT water and there was little pressure to reallocate supplies. Until about 1961, the market value of C-BT water was zero.[56] Purchase records of municipal water departments and rural-domestic water service organizations indicate that the market price for C-BT units became established in the early 1960s at a price of about $95 per acre-foot. With each C-BT unit representing a long-term average yield of about 0.75 acre-feet, the average price of C-BT water was about $125 per acre-foot. Through the 1960s and 1970s, prices for C-BT water climbed at an accelerating rate. Prices reached $220 per acre-foot in 1963, $560 by 1967, $860 by 1971, over $1,000 by 1974, over $2,500 by 1977, and $3,600 by 1980. After 1980, prices began to decline again rapidly. In 1981 prices fell to below $3,000 per acre-foot, to less than $1,600 by 1983, and to about $1,000 by 1985.

Shares of stock in the North Poudre Irrigation Company are considered by many in northeastern Colorado to be the most marketable water rights in the NCWCD after the C-BT. The company's issue of 10,000 shares of stock is held by a variety of municipal and industrial, rural-domestic, and agricultural water users within a service area covering much of the northern portion of the NCWCD. The long-term average yield on each share of stock is just under 6 acre-feet per year. Stockholders may split their shares up into quarter-shares representing an average yield of about 1.5 acre-feet per year in order to buy and sell smaller quantities of rights. There were 9,926 shares of stock outstanding (in general circulation) in 1984. A substantial portion of the water rights controlled by the company consist of senior direct flow rights, reservoir rights, and C-BT units.[54, 57]

North Poudre water stock is an extremely marketable commodity similar to C-BT water rights in several ways. Both have large and reliable water supplies available to many different types of users, serve an extensive geographical area, have a large number of available shares, and allow small quantities of water to be transferred in a single transaction. Typical prices for North Poudre stock have followed the historical movement of C-BT prices. On an acre-foot basis, North Poudre water generally sells for between 60% and 70% of the going market price for C-BT units.[54]

Comparable acre-foot quantities of other water rights within the NCWCD typically sell for 50%, 35%, or even less than 20% of the market value of C-BT water. These are water rights that tend to be less transferable. Some are available for use by only a relatively small number of potential buyers within a limited geographical area. Some provide water that is locked into agricultural use, and their transfer to a nonirrigation use would require potentially expensive legal proceedings. In addition, many of these alternative water supplies are either not reliable or are unavailable in a form useful to the buyer. Most of the adjudications for irrigation rights in northeastern Colorado restrict use to certain times of the year only. Many water rights cannot legally be used for more than a few months during the spring and summer. Municipal and rural-domestic water suppliers, whose customers demand steady supplies of water throughout the year, have a limited demand for highly seasonal water rights.[57] The less flexible ditch rights, privately adjudicated water rights, small private reservoirs, and groundwater rights are rarely sold apart from the land to which they are deeded. Most often these water rights are retained for agricultural use and their market values are low.[54]

Windy Gap water has the potential to become one of the most flexible and marketable water resources in northeastern Colorado. Windy Gap is reputed by many to be one of the major reasons for the sudden turnaround in skyrocketing water rights prices during the early 1980s. Windy Gap has only recently been completed, however, and there are many uncertainties about its ultimate cost and usefulness. There are two main barriers to buying and selling primary rights to Windy Gap water at the present time—the high cost of participation in the project, and the system of ownership. Windy Gap is the most expensive source of primary water rights in northeastern Colorado. The current annual cost to project participants, including bond debt service and operation and maintenance costs, is between $200 and $300

per acre-foot. Participants in the project hold prorated shares of bonded indebtedness in proportion to their entitlement to the water. The sale of primary Windy Gap water necessitates the transfer of an equal share of the bonded indebtedness, which can be a very complex transaction.[54]

Few transfers of the primary water rights in the Windy Gap Project have taken place thus far. The best examples are two sales by the town of Estes Park. In the summer of 1985, the town sold an interest in 100 acre-feet per year to the Central Weld County Water District for about $510 per acre-foot. In the fall of 1985 Estes Park concluded another agreement to sell 3,700 acre-feet of primary Windy Gap rights to the city of Broomfield for about $415 per acre-foot.[58]

Interest in the Windy Gap Project remains high despite the cost of the water relative to the current market price for alternative water supplies in northeastern Colorado. Participants in the project believe the advantages of having Windy Gap water will prove to be worth the costs because they own not only rights to primary flows but also the return flows. They are free to recycle their shares of Windy Gap water by selling the return flow to a downstream user or by applying it to water exchanges or groundwater augmentation plans.[59] Since Windy Gap is operated jointly with the C-BT and they share a common service area (the service area for Windy Gap is actually larger than and includes the NCWCD), Windy Gap will share the same market area and have many of the same market advantages that C-BT water has.

Water rights purchased from agriculture by nonirrigation users are rented back to agriculture in large quantities every year. Municipal and rural-domestic water service organizations maintain large inventories of water rights in order to protect their users against fluctuations in supply. On the average, less than half of the C-BT units owned by nonagricultural water users are actually used. Since the NCWCD does not carry over unused water rights to subsequent years, shareholders have an incentive to at least cover the costs of assessing the units by renting the water to other users. Almost the only buyer for rental water in the district is irrigated agriculture, although in a few cases nonagricultural water service organization have also rented water.[56]

The rental market for C-BT and other types of water rights in northeastern Colorado exhibits none of the price trends observed in the purchase and sales of rights. Prices have remained low, with no definite trend over time, varying between about $5 and $20 per acre-foot. With the development of the Windy Gap Project and with urbanization continuing in the NCWCD, it does not appear that rental water will become more scarce in the foreseeable future. More and more water rights have been acquired for development by municipal and rural-domestic organizations and offered for rent to agricultural users. Meanwhile, irrigated acreage continues to decrease and agricultural demand for water is declining. Even in relatively dry years and even at prices that are equal to or only slightly above the cost of the annual assessment costs for their water rights, renters frequently fail to find enough takers for all of their surplus water.

Southeastern Colorado

Activity in the southeastern Colorado water market is at once much simpler and more difficult to describe than the market in northeastern Colorado. Southeastern Colorado is simpler to describe because there has been much less market activity than in the NCWCD. However, most of the important water rights transfers have necessitated extensive negotiation and litigation over controversial issues and complex details.

More than a dozen different transmountain diversion projects bring some 200,000 acre-feet of water per year into the Arkansas River basin. Of all the transmountain diversions, however, only the 50,000 acre-feet of water provided through the Twin Lakes Reservoir and Canal Company have ever been marketed. Nearly all of the Twin Lakes stock came onto the market and was sold within a period of about 5 or 6 years in the 1970s.

The approximately 45,000 shares of outstanding stock in the Twin Lakes company were all originally owned by farmers within the service area of another irrigation water provider, the Colorado Canal Company, located about 50 miles east and downstream of the city of Pueblo along the Arkansas River. Two other water service organizations located in the same general area are the Henry and Meredith Reservoir Companies. These four irrigation companies provide three different types of water rights—transmountain diversion and some native flow water from Twin Lakes, native flow rights through the Colorado Canal, and reservoir rights from Henry and Meredith Lakes. Most farmers owned stock in all four water companies and had their water delivered to them through the Colorado Canal system.[43]

Until about 1970, farmland in the Colorado Canal company service area sold for about $500 per acre, including land and all water rights. In the early 1970s an investment group called the Crowley Land and Development Company (CLADCO) offered farmers in the area about $900 per acre. Despite heated local opposition, farmers in the area sold a majority of their land and water company stock to CLADCO. As a result, slightly over 60% of the Twin Lakes stock changed hands. Nearly all of the remaining stockholders formed a coalition that became known as the Proxy Group.

CLADCO and the Proxy Group successfully obtained a decree in water court to change the purpose of use for Twin Lakes water rights from irrigation to multiple use.[60] The status of the other native flow and reservoir water rights appurtenant to lands in the Colorado Canal service area were not affected by this decision. Twin Lakes stock suddenly became one of the most flexible and valuable sources of water in the area, and nonagricultural users quickly bid up its price.

Between 1972 and 1975 CLADCO and the Proxy Group each sold large quantities of Twin Lakes water stock to the cities of Pueblo, Pueblo West, and Colorado Springs for prices ranging from about $2,300 to $2,400 per acre-foot. In 1976 another lot of Twin Lakes stock that had been transferred from CLADCO to the Aetna Group was sold in turn to the city of Colorado Springs for slightly over $2,300 per acre-foot. Only six sales of Twin Lakes

stock by CLADCO, Aetna, and the Proxy Group (one to Pueblo West in 1972, two to Pueblo in 1972 and 1973, and three to Colorado Springs in 1972 and 1976) accounted for the transfer of over 43,000 shares, or the vast majority of the shares of all Twin Lakes stock.

Other transfers of Twin Lakes stock for nonagricultural users occurred during the mid–1970s. Pueblo West bought a farm with 237 shares of Twin Lakes stock in 1971, for about $1,400 per acre, including all land, improvements, and water rights. The farm is still in operation and is continuing to use the water rights until Pueblo West wants them. Pueblo West acquired another 117-acre farm with Twin Lakes water rights from a real estate development corporation, but the amount paid is unknown. Colorado Springs bought a total of approximately 500 acre-feet from miscellaneous owners during the summer of 1976 for an average price of over $2,000 per acre-foot. Aurora acquired approximately 2,500 shares of Twin Lakes stock in 1973 for $2,675 per acre-foot.

Very little specific price information is available on the sale of other shares of Twin Lakes stock. Small quantities have reportedly been sold to homeowners in mountain resort communities. As an alternative to purchasing less expensive but also less flexible native stream rights and undertaking potentially lengthy and expensive water court transfer proceedings, some individuals have preferred to purchase shares of Twin Lakes stock for prices ranging from $8,000 to over $10,000 per acre-foot.[43]

In 1983 and 1984, the Colorado Foundry & Iron (CF&I) Steel Corporation sold its storage rights in Tourquoise Reservoir to the cities of Colorado Springs, Pueblo, and Aurora. Colorado Springs purchased 17,470 acre-feet of storage rights, plus two direct flow rights totaling about another 4,200 acre-feet, for about $400 per acre-foot. The city purchased the rights primarily for the reservoir storage space, which it can use to facilitate the exchange, storage, and delivery of water supplies developed from numerous other sources. These sources include water from the Homestake and Blue River transmountain diversion projects as well as various direct flow and storage rights acquired in the Arkansas River basin. The 4,200 acre-feet of direct flow rights that Colorado Springs acquired from CF&I are considered unimportant, as they are too junior in priority to be very dependable.[61]

In the fall of 1986 Colorado Springs closed on a deal to transfer 17,500 acre-feet of direct flow and storage rights in a complex transaction involving three different water companies. The package included land, improvements, and water rights in the Henry and Meredith Reservoirs and the Colorado Canal Company. The seller, Foxley and Company, had acquired the property from CLADCO, which had purchased it originally in order to market the shares of Twin Lakes stock associated with the lands. Foxley sold its interest in the companies to Colorado Springs for a total of about $27.75 million, or slightly under $1,600 per acre-foot.[62]

Henry and Meredith Reservoir rights were valuable to Colorado Springs, not only for the deliverable quantities of water, but also for the reservoir storage space. Colorado Springs may store unused water from some of their direct flow water rights in the Henry and Meredith Reservoirs should there ever be insufficient storage capacity in Pueblo Reservoir. Water stored in these reservoirs is then available to serve downstream users who in turn may exchange their flow rights to Colorado Springs for water upstream in the Pueblo Reservoir.[61]

Until recently, Colorado Springs hardly utilized its legally reusable return flow water. A small portion of water has been marketed to downstream users for their groundwater augmentation plans. The price charged for the sale of return flow in 1985 was about $235 per acre-foot. In 1986 the price was increased to about $260 per acre-foot. Additional small quantities of return flow have been used for urban irrigation. Most of the water, however, was simply released into the Fountain River where it flowed downstream to mingle with the Arkansas. In recent years, Colorado Springs has begun ambitious efforts to reclaim all of its legally reusable return flow. The city wishes to expand its reuse of return flow significantly by substituting an average of 34,000 acre-feet of return flow per year for stored water in Pueblo Reservoir.[61] Depending upon the outcome of its first return flow case in court, Colorado Springs anticipates reclaiming up to another 30,000 acre-feet of water through similar exchange programs. It is not known how much, if any, of the reclaimed return flow may eventually be marketed to other water users.

The City of Fountain is a small town 10 miles south of Colorado Springs in the Fountain Valley. Fountain used to derive all of its water from the Mountain Reservoir. The city was forced to seek an alternative source when state health authorities ordered expensive renovations in the water treatment system. Fountain first considered purchasing a groundwater wellfield about 20 miles to the east in the Black Squirrel basin, but local opposition successfully blocked the sale. Fountain then developed its own wellfield in another area during the 1960s. With the closing of the area to further groundwater appropriation and the passage of new groundwater management legislation, Fountain had to acquire additional water rights to compensate for its groundwater pumping. Part of its legal obligations are met by releasing water from the Mountain Reservoir. The rest is met through the retirement of water rights associated with Fountain Valley Mutual Irrigation Company water stock, which Fountain has been gradually purchasing for several years. With the completion of the Fountain Valley Pipeline in 1985, Fountain now also has the option of purchasing Fry-Ark water. Fountain has also considered purchasing additional groundwater rights in the area, but the water quality is poor and the asking price for the rights is too high.[63]

The city of Pueblo is located along the Arkansas River just below Pueblo Reservoir, about 30 miles east of the Front Range. In addition to its participation in the Frying Pan-Arkansas Project and its acquisition of stock in the Twin Lakes Company, it has purchased a number of shares of stock in other ditch companies and has constructed some water development projects of its own. Pueblo's principal water company acquisitions in recent years have been the purchase of storage rights in the Otero Canal Company, the Booth-Orchard Canal Company, and storage and flow rights in the Rocky Ford

Highline Canal Company.[64] The city also bought storage rights in Tourquoise Reservoir from CF&I Steel Corporation in 1983, paying about $440 per acre-foot for 5,000 acre-feet of storage rights. Another 5,000 acre-feet of storage rights were sold at about the same time to the City of Aurora for the same price. In two separate transactions in 1967 and 1969, Pueblo paid to the City of Aurora between $2,500 and $3,600 per acre-foot for the right to lease up to 2,500 acre-feet of water per year from Aurora, at a normal charge of $3 per acre-foot.

Pueblo offers its unused reservoir and transmountain diversion water rights for rent each year. Direct flow rights are not rented because their transfer to another user, even for only a season, would require proceedings before the water courts. Pueblo's Twin Lakes water is offered for lease at a predetermined price. A recent large surplus of rental water on the market forced Pueblo to reduce its asking price from $18 to $10 per acre-foot. Prices for other types of water are determined on the basis of closed bids solicited by the city. The town of Pueblo West, which also offers water for rent each year, regularly trades information with Pueblo on the bids each has received from prospective buyers. Pueblo generally sets a floor on its rental prices and will not offer water below that minimum price, even if as a consequence it is left with large quantities of unrented water. The city of Aurora regularly leases Twin Lakes water from Pueblo, paying a unit price equal to the highest bid received by Pueblo for its water that year.[64]

Pueblo West is a resort community several miles west of the city of Pueblo near the base of the Front Range. Pueblo West began developing its water supply in the 1960s by drilling several groundwater wells. Most of the wells drew poor quality water, and the potable water available from the wells was not sufficient to support a sizable community. In the early 1970s, Pueblo West purchased shares of Twin Lakes water stock and negotiated an agreement with the SCWCD to store the water in Pueblo Reservoir. The municipality now owns enough water rights to serve a population ten times its current size. Each year the extra water is made available to whoever wants to lease it. The rental prices are determined through closed bids. Real prices since 1982 have varied from as little as $3 per acre-foot to over $30 per acre-foot. Pueblo West has never succeeded in renting all of its unused water rights. Since 1982, it has rented as many as 1,680 acre-feet and as few as only 331 acre-feet.[65]

The City of Aurora, a fast-growing metropolitan center just east of Denver, concluded another three major acquisitions of water rights at the close of 1986. A majority interest in the Rocky Ford Ditch Company was acquired, giving the city 8,200 acre-feet of water at a cost of about $2,500 per acre-foot. Following the successful transfer of water from the Colorado Canal Company by Colorado Springs, Aurora picked up its own 5,600 acre-feet from the Colorado Canal Company, also at a cost of about $2,500 per acre-foot. Finally, Aurora acquired 45% of the outstanding shares of stock in the Busk-Ivanhoe Ditch Company, yielding about 3,000 acre-feet at a cost of $3,500 per acre-foot. The city was willing to pay a premium price for the Busk-Ivanhoe stock because they represent transmountain diversion rights, which are both legally and hydrologically easier to transfer to the South Platte basin than are native flow and storage rights in the Arkansas River.

Other examples of large blocks of water rights offered for sale in the Arkansas River basin include the Bessemer Ditch and the Huerfano-Cuchares Ditch Companies. In 1986 the Huerfano-Cuchares Ditch Company, which had been offered for $13 million, sold for about $10 million. The quantity of transferable water rights is currently under study. Historic diversions by the company have totaled about 6,800 acre-feet per year, of which perhaps half may have been used consumptively and are therefore available for transfer. In addition, Huerfano-Cuchares has an adjudicated right to 60,000 acre-feet of storage water, although the reservoir is in need of repair and at the present time cannot hold more than 35,000 acre-feet.[66]

The 10,000 shares of the Bessemer Ditch Company are being offered for $60 million, or $6,000 per share. Each share has an average yield of 3 acre-feet. It has not yet been established how much of this average yield may be transferred out of the company service area. Previous to this offer, the market price for the stock among irrigators had been between $1,200 and $1,500 per share.[66]

Prospective buyers of water rights in the Arkansas basin have not forgotten the disastrous purchase of water rights by the state Game and Fish Commission in 1971. Up until that time, shares of stock in the Catlin Canal Company, with a long-term annual average yield of 4 acre-feet per share, had been selling for about $160. The Game and Fish Commission bought 2,097 shares in the company at a cost of about $320 per acre-foot, intending to transfer the water rights to a large reservoir along the river for fish and wildlife habitat. The remaining stockholders in the Catlin Canal Company successfully opposed the transfer by arguing that their water rights would be impaired. The Game and Fish Commission appealed the decision, which was eventually upheld by the state Supreme Court. Over $2.5 million (not including court costs) was paid by the State for water rights that could not be transferred for their intended use.[67]

To summarize, market transfers of water occur in Colorado under highly diverse conditions. Appropriated water rights represented by water company stocks having a large service area and approved for multiple uses can be readily transferred. As is apparent from other types of transactions in the Northern and Southeastern Colorado Water Conservancy Districts, market transfers can also be subject to expensive, time-consuming, and complex approval procedures and litigation.

TRUCKEE RIVER BASIN, NEVADA

Description of the Study Area

The market area chosen for study in Nevada includes the Truckee River Basin and adjacent areas in southern Washoe County, Story County, and parts of Churchill and Lyon Counties. Most of the area's population of

250,000 is concentrated in and around the twin cities of Reno and Sparks, which are located in a valley known as the Truckee Meadows. The Meadows are flanked on the west by the Sierra Nevada Mountains and on the east by the Great Basin. Most agricultural activity is concentrated in the Newlands Project, about 50 miles east of the Truckee Meadows. The Newlands Project, managed by the Truckee-Carson Irrigation District (TCID), was one of the first irrigation projects built by the Bureau of Reclamation in the early 1900s. These areas are shown in figure 5.

The Truckee begins at Lake Tahoe in the California Sierras, crosses the state line into Nevada, and flows east past irrigated farms and ranchlands surrounding the metropolitan centers of Reno and Sparks in the Truckee Meadows. Eventually it approaches the western edge of the TCID near the town of Fernley, where the river turns north to empty into Pyramid Lake on the Pyramid Lake Indian Reservation.

Nevada is the driest and one of the fastest growing states in the United States. Reno and Sparks are regional centers of tourism and commerce and their populations are expanding rapidly. Rights to Truckee River water are highly controversial. Conflicts among the cities, Native Americans, fish and wildlife managers, and irrigated agriculture have continued unabated for most of the 20th century.

An average of approximately 650,000 acre-feet of Truckee River water is used per year in northwestern Nevada. Roughly 50,000 acre-feet is used for municipal and industrial purposes in the Truckee Meadows, while 300,000 acre-feet is used for irrigation. Irrigation uses are divided among farms in the TCID (190,000 acre-feet), and other farms and ranches (about 105,000 acre-feet). About 300,000 acre-feet of Truckee River water flow into Pyramid Lake.[68] Consumptive use of the water rights along the Truckee River has risen over time, and as a result the quantity of water emptying into Pyramid Lake has declined. Falling lake levels have alarmed sportsmen, conservationists, and especially the Pyramid Lake Indians.[69]

On average, about 375,000 acre-feet of water are used annually by TCID from rights developed on the Truckee River and on the Carson River, which parallels the Truckee 20 miles to the south. Water taken from the Truckee River by TCID is carried by the Truckee Canal into Lahontan Reservoir, where it mingles with roughly an equal quantity of water from the Carson River before its distribution over TCID's 75,000 irrigated acres. By a joint agreement among the TCID, the State of Nevada, and the U.S. Fish and Wildlife Service, return flows from the Newlands Project are allowed to dissipate in marshlands to the east of the TCID to support the Stillwater Wildlife Refuge.

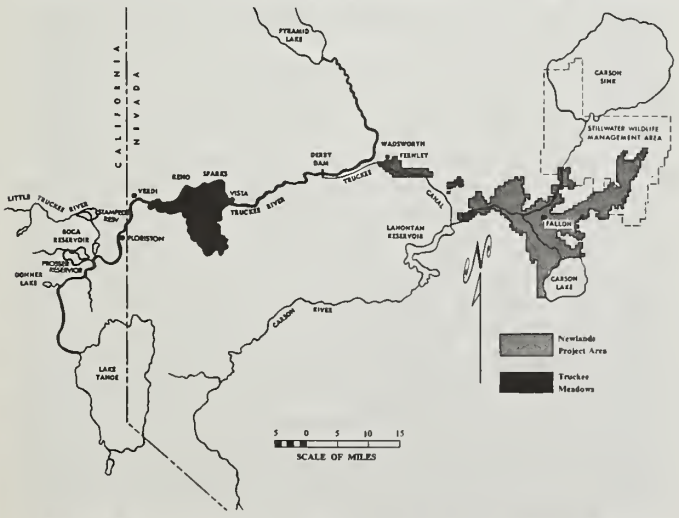

Figure 5.—Northwestern Nevada: The Truckee River Basin.

Approximately 10,000 acre-feet of groundwater are used annually for municipal and industrial purposes in the cities of Reno and Sparks. A small number of domestic users in the Truckee Meadows area outside of Reno and Sparks and a few irrigators use another 2,000 to 3,000 acre-feet per year. There is limited groundwater pumping in the TCID by individual users; the district itself has no groundwater rights. Groundwater quality is highly variable within the Truckee Meadows. It can be very poor in the southern and eastern portions of the area owing to the presence of heavy metals. In some locations, the water is so poor that it cannot be used unless it is mixed with purer water from the Truckee River. Groundwater withdrawals in the Truckee Meadows are carefully regulated by the State Engineer because of the danger that excessive pumping could draw poor quality water into the more potable aquifers.[70]

Market transfers of water in the general area of the Truckee River basin have been confined mainly to the Truckee Meadows. A small number of groundwater rights transfers have occurred in some nearby valleys. Regional water transfers involving the TCID, the Pyramid Lake Indians, and the Stillwater Wildlife Management Area are legally difficult and have not yet been attempted. These areas are nevertheless included in the study because the management of their water resources continues to have a significant impact on the availability of water supplies in the Truckee Meadows water market. Nonagricultural water users located outside of the existing or planned service area of Sierra Pacific generally have had to rely on local groundwater supplies to meet their water demands. Because the basins in northwestern Nevada are closed to additional appropriation, and because exempt groundwater wells are too small and inadequate for most purposes, new water users have had to acquire water rights by transferring them from existing users.

Municipal and industrial customers in the Reno-Sparks area receive gas, water, and electrical service from the Sierra Pacific Power Company, a privately owned utility. The Washoe County Public Works Department provides some water service to outlying communities in the Reno-Sparks area. A few communities have been serviced by private water companies, several of which have been taken over recently by Washoe County. Irrigators outside TCID hold individual decrees for water in the Truckee River, which is distributed to them by private ditch companies. A number of ditch companies once provided Truckee River water to irrigators in the Truckee Meadows. Many of these companies are now inactive because the lands within their service areas have

been developed and their water rights transferred to Sierra Pacific.[69]

Lake Tahoe and Boca Reservoir serve as area-wide regulatory and storage facilities for the Truckee River; in addition, Sierra Pacific operates two small privately owned reservoirs, Donner and Independence Lakes. A third facility, Stampede Reservoir, was originally developed by the Bureau of Reclamation as a multipurpose, supplemental water supply. The water supply, however, was preempted to support fish habitat and has never been made available for municipal use. Sierra Pacific is attempting to work out a compromise solution with the federal government whereby at least some water may be made available to the company.[70]

Water Laws and Institutions

For several decades Nevada has applied the appropriation doctrine for administering both groundwater and surface water resources.[71] The Office of the State Engineer was created in 1903 with the passage of Nevada's first comprehensive water law, passed primarily to provide a method by which the existing rights to appropriated water might be defined, regulated, and protected. Relatively few changes in the basic water laws have occurred since 1939 when legislation declared all groundwaters not hitherto subject to the appropriation doctrine to be explicitly included. Small domestic wells were exempted from regulation. Nevada's general policy towards groundwater has been to restrict withdrawals from a given basin to hydrologically safe yield levels.[46]

In the 1960s, Sierra Pacific began developing groundwater rights in the Truckee Meadows to supplement its surface water rights on the Truckee River during periods of peak demand. Rights to 48,000 acre-feet per year have been appropriated, but this is far in excess of the area's hydrologically safe yield. The State Engineer and Sierra Pacific have agreed to maintain groundwater pumping at 8,000 to 10,000 acre-feet per year while permitting as much as 12,000 acre-feet to be withdrawn under short-term critical conditions.[70]

The State Engineer has primary reponsibility for distribution of all water in Nevada except federally decreed stream systems, which are administered by a Watermaster appointed by the federal district court. The federal Watermaster distributes water according to the priority dates of the water rights, and the established operating criteria for the stream system. Under the Watermaster's supervision, water is diverted from the main stream into ditches owned by water companies. The water companies then distribute the water among individual users according to their rights.

The Truckee River is a federally adjudicated stream administered under the Orr Ditch Decree of 1944. About 29,000 acre-feet of water per year were allocated to the Sierra Pacific Power Company, over 230,000 acre-feet per year to the Newlands Project (TCID), and 177,000 acre-feet per year for irrigation on other lands. Another 30,000 acre-feet per year were designated for irrigated agriculture on the Pyramid Lake Indian Reservation.[72] The Sierra Valley Water Decree of 1958 confirmed the right of the Sierra Valley Water Company of California to divert an average of 10,000 acre-feet per year from the Little Truckee River. These water rights are also subject to the Orr Ditch Decree and are administered by the federal Watermaster as part of the Truckee River system.

No water was allocated under the Orr Ditch Decree specifically for the purpose of maintaining the level of Pyramid Lake or streamflows in the Truckee River itself. The Pyramid Lake Indians, who derive much of their livelihood from fishing the lakes and rivers, have contested this omission. In recent years they have been partially successful in winning some concessions in their battle to protect lake and stream habitat for two endangered species of fish, the cui-cui and the Lahontan cut-throat trout.

Although water rights under the Orr Ditch Decree were assigned on the basis of prior appropriation, water is distributed on a prorated basis. Minimum levels of flow in the river at selected points along the stream are maintained according to operating criteria set forth in the Truckee River Agreement of 1935.[72] The operating criteria provide for the servicing of all appropriations on the river and for the proration of all claims in the event of insufficient water supplies. Modified operating criteria are used during drought conditions. The operating criteria become ineffective only during severe droughts, such as occurred during a few years in the 1930s and once again for a brief period in the late 1970s. When this happens, the federal Watermaster may resort to a system of relative priorities.[68] Under these extreme conditions, the 29,000 acre-feet of water rights assigned to Sierra Pacific have priority over all irrigation rights.[69]

The operating criteria for the Truckee River have been the focus of continuing controversy for many years. Lack of technical information about the river system has exacerbated the conflicts. In an effort to help resolve the disputes, Sierra Pacific hired an engineering consultant to study the hydrology of the Truckee River basin and to produce a model for planning purposes. All major factions have now accepted the authenticity of the consultant's data, although negotiations continue over the choice of priorities and objectives to use in operating the model.[73]

Guidelines regulating the transfers of water rights in Nevada are few. The primary condition is that the transfer does not impair existing water rights or otherwise appear detrimental to the public interest. The State Engineer's Office oversees any prospective change in the point of diversion or place or purpose of use of any groundwater or surface water right in Nevada, including those on federally decreed streams. A water right is considered a property right and is protected as such. When water rights are granted they are appurtenant to a given piece of land for a specific purpose. Generally, when land is sold all water rights appurtenant to the property described in the deed automatically transfer to the new owner. However, application to the State Engineer may be made to sever the water right from the land to retain it or convey it separately.

In a federally adjudicated stream system such as the Truckee River, the State Engineer consults with the federal Watermaster on administering water rights transfers in the system under the directives of the federal decree. As long as the transfer is compatible with the operating criteria for the river, it may be approved. Water rights transfers on the Truckee River have not been limited to only the consumptive use portion of the right. Temporary water rights transfers (leases) have not been permitted on the Truckee River. The federal Watermaster has opposed leasing water rights, arguing that leasing would overly complicate the administration of the river.[68]

Water Market Activity

No water market activity has occurred within the Pyramid Lake Indian Reservation. The community is unlikely to enter the marketplace because it has had some success in securing minimal streamflows through nonmarket strategies. Furthermore, the quantity of water the tribe needs to control the level of Pyramid Lake would require a considerable sum of money, even if the water were legally transferable and a sufficient number of willing sellers existed. Relying on nonmarket water transfer strategies, the Pyramid Lake Tribe has effectively been able to gain access to water, although the rights are not formally recognized by the State Engineer.

The Pyramid Lake Tribe has won concessions on two fronts, and in both cases their victories have had an impact on the water rights available for other users along the system. Their first success was Stampede Reservoir, which was built by the Bureau of Reclamation in eastern California in 1970 to aid in regulating the flow of the Truckee River. The reservoir originally was conceived of as a multipurpose water project, but no water has ever been diverted from it for either irrigation or municipal and industrial uses. Since the early 1970s, the federal government has allocated all the water in the reservoir to help maintain the level of flow and the temperature of the Truckee River for fish habitat. The reservoir will continue to be used for this purpose so long as the native trout species in the Truckee River and in Pyramid Lake are considered endangered. Sierra Pacific Power Company had counted on receiving a substantial allocation of water from the reservoir. Appeals by Sierra Pacific and the State of Nevada against this decision thus far have been unsuccessful.

Another success for the tribal community was a change in the operating criteria for the Truckee River system initiated in 1985. Water supplies released for irrigation purposes both inside and outside of the TCID have been reduced by several tens of thousands of acre-feet per year. Conservation requirements for reducing evaporation and seepage losses are being enforced.[68]

Water rights in the TCID are difficult to transfer. TCID is a federally funded and administered project, and ownership of water rights used on project lands by individual water users has been unclear. Financial obligations to the project are based on land ownership and not water usage. There is no established procedure in the Newlands Project for transferring project assessments with water rights that are transferred off of project lands.[74] The district's water supply is a mixture of water from two different river systems each of which is administered under its own federal decree. The relative proportions of water from each river system have varied from year to year with changes in relative flow levels in each river. It is thought that any attempt to transfer water rights outside of the TCID would create serious legal and administrative problems for the management of the Newlands Project.[68]

Until recently, no transfer of TCID water rights had been permitted into, out of, or within the district. Federal adjudication of the Carson River in 1983 established the legality of water rights transfers within, but not into or out of, the district.[75] By mid–1985 about 100 proposed water rights transfers within the district had won provisional approval from the State Engineer.[74] Final approval of the water rights transfers within TCID are being withheld pending an appeal by the Pyramid Lake Indians.[75] The outcome of this case will have a strong bearing on whether or not water transfers will become common in the TCID. No price data were collected on transfer of TCID water rights, which are exclusively surface water rights. Groundwater rights in the Fallon area of the district are reportedly selling for about $300 per acre-foot.[73]

Sierra Pacific began purchasing irrigation rights to supplement its original Truckee River appropriations in the mid–1940s, and continued to acquire additional water rights actively until 1979. Real prices ranged from a low of about $35 per acre-foot in 1946 to a peak of about $160 per acre-foot in the mid–1960s. From 1966 to 1979, the real price per acre-foot for water rights fell steadily. Most of the water rights acquisitions during the period 1946 to 1979 actually occurred between the late 1950s and 1970.

The present water market developed in the Truckee Meadows during the mid to late 1970s when the U.S. Department of Interior refused to provide water and storage rights in the Stampede Reservoir for municipal and industrial purposes. Sierra Pacific had been counting on receiving between 17,000 and 34,000 acre-feet of additional water rights and regulatory storage space in the reservoir for a cost of about $17 per acre-foot per year. Meanwhile, Sierra Pacific's rate of acquiring additional irrigation water rights from irrigators had been declining as the real price offered by the company to farmers dipped below $75 per acre-foot. Unprecedented rates of urban growth in Reno and Sparks threatened to outpace Sierra Pacific's capacity to serve them with additional water. In 1978 Sierra Pacific commissioned an independent study of its water resources and projected demands. The report concluded that the current rates of growth in water use in Sierra Pacific's service area would exceed the firm yield of the company's existing water rights inventory and would be insufficient to meet demand within two or three years.[76]

A water crisis hit the Truckee Meadows seemingly overnight. Holders of water rights on the Truckee River

recognized that they possessed a scarce and valuable commodity. Landowners who had until then subdivided their holdings indiscriminately with the water rights appurtenant began to sever the water rights from the land to sell them separately. Sierra Pacific was reluctant to pay the increased costs for water rights. In 1980, the utility raised its offer price for water rights to a range of $95 to $135 per acre-foot, based on relative water rights priority dates. Later it raised its offer price to $140 per acre-foot, and eventually to $250. The increase, however, was not enough to attract sufficient numbers of sellers, who found many other buyers in the Truckee Meadows willing to pay $1,500 and more per acre-foot. Water rights acquisitions by Sierra Pacific slowed to a trickle as potential sellers held out for higher prices.

Faced with an impending water shortage, Sierra Pacific began rationing additional water service. New water users were put on a lengthy waiting list pending the acquisition of sufficient water rights. The creation of the waiting list touched off an intense battle between government and industry and between pro-growth and no-growth advocates. Private developers and the cities of Reno and Sparks accused the utility company of becoming a self-appointed regional planning agency.[77] Environmental groups critized the cities for trying to grow beyond their means.

Throughout the early and mid 1980s, a series of interactions among Sierra Pacific, private interest groups, the State Public Service Commission, and the State, county, and local governments created new legal and administrative infrastructures to accommodate the pressures for a more efficient, equitable, and workable system of water rights transfers in the Truckee Basin. The new system was largely in place by the spring of 1985. Under a ruling of the Public Service Commission, Sierra Pacific is required to provide water service to approved new developments within 60 days.[78] Water rights are provided by the appropriate local government (the cities of Reno or Sparks, or Washoe County) through long-term (99-year) leases.[77, 79]

The water rights inventory of Sierra Pacific and the additional water rights available for purchase in the 1980s in the Truckee Meadows and elsewhere is as follows. Sierra Pacific has water rights with an average yield of roughly 79,000 acre-feet per year. This includes 29,000 acre-feet of originally adjudicated flow rights in the Truckee River, 12,000 acre-feet of groundwater, and 38,000 acre-feet of additional surface water rights acquired since 1944. Approximately 38,000 acre-feet of water rights are still used for irrigation, 28,000 acre-feet in the Truckee Meadows area and 10,000 acre-feet in Sierra Valley, California. Finally, an estimated 32,000 acre-feet of water rights formerly used for irrigation are no longer in use. These water rights are still appurtenant to lands that were incorporated into the service area of Sierra Pacific and were provided with water service without ever having the water rights severed.[70]

Sierra Pacific has determined that the firm yield (the minimum yield from the water rights that could be expected under the worst drought conditions) averages about 58% of the long-term average yield for these water rights. Sierra Pacific's original appropriation of about 29,000 acre-feet per year, however, is given the highest priority on the river and has a firm yield of 100%.

In accepting water rights in exchange for water service, Sierra Pacific established the following guidelines. The water rights have to produce a firm yield of water sufficient to meet the estimated water demand for the proposed development. Firm yield is defined as 58% of the long-term average yield of the water right. The water rights have to be decreed Truckee River water rights. If the new development is already within the service area of Sierra Pacific, the water right may come from either within or from outside the service area boundaries. If the new development is located on land that the applicant was seeking to have annexed into Sierra Pacific's service area, then the water right has to come from outside the current service area boundaries. Under certain circumstances Sierra Pacific will consider accepting groundwater rights, if they have valid permits and it can be demonstrated that the water is of acceptable quality.

The local governments acquire the water rights they lease to Sierra Pacific from two different sources. Most of the water rights are provided by developers who are required to dedicate sufficient water rights to the local governmental jurisdiction as a precondition for project approval. Sierra Pacific assists prospective buyers of water rights by providing a list of names of interested water rights sellers. The list is periodically updated and is available upon request from the company. The cities are slowly acquiring additional water rights under a special program created by state legislation regarding the disposition of the estimated 32,000 acre-feet of unused irrigation rights appurtenant to lands served by Sierra Pacific. The cities of Reno and Sparks and Washoe County are authorized to acquire by purchase or by condemnation, if necessary, the water rights appurtenant to these lands.[80] Water rights acquired by the cities are "banked" by the appropriate local government authority until such time as the city or county wishes to use them in support of a particular development project.[77]

Prices for water rights in the Truckee Meadows and outlying areas vary considerably. Groundwater prices usually are low because groundwater quality generally is lower than surface water quality, and legally the rights tend to be more difficult to transfer. Since 1983 Washoe County has been acquiring private water companies serving groundwater to customers in rural areas. It began the program of acquisitions because of concerns about the poor condition of many of the companies and potential health problems posed by their deteriorating facilities. As a condition for taking over the companies, the county generally has required that the owners sell all assets and rights of way necessary to provide water service to existing customers, including water rights, for an amount not to exceed the cost of the initial investment. For the water rights the initial investment might be no more than the cost of the filing fees for the appropriation of the water right, a total of about $100.[81]

In one exceptional acquisition in January, 1984, Washoe County acquired a water company but purchased a quantity of water rights separately from the

other assets. The Trans Sierra Water Company had an appropriated but as yet undeveloped right to pump 2,600 acre-feet of groundwater over and above what it was already pumping to serve its existing customer base. The county was interested in acquiring the rights and entered into negotiations with the company for their purchase. Initially the company offered the rights for $1,500 per acre-foot, an amount equal to the current price for Truckee River rights. Washoe County refused the offer, arguing that the groundwater rights were not as transferable as surface water rights, were not available for use in the areas of high water demand, and therefore could not be valued equally. Furthermore, the rights had not yet been developed and were in danger of being forfeited. Eventually Trans Sierra relented and sold the rights to the County for $50 per acre-foot.[81]

Other groundwater rights in northwestern Nevada have sold for substantial sums of money. In some isolated groundwater basins near the Reno-Sparks area where development pressures are strong but municipal water service is not readily available, prices have risen to unusually high levels. In recent years, for example, groundwater rights in the Spanish Springs and Lemon Valley areas near Reno and Sparks have sold at prices ranging between $4,000 and $10,000 per acre-foot.[73]

In contrast to groundwater rights, surface water rights in northwestern Nevada are almost always highly valued, although prices still vary. Highest prices are observed for large, consolidated blocks of rights appurtenant to lands located outside the existing service area of Sierra Pacific. Lowest prices are observed for small rights appurtenant to urbanized lands within the Reno-Sparks metropolitan area which are already served water by Sierra Pacific. An independent water rights appraisal conducted in 1984 listed 52 water rights transactions occuring between 1982 and 1984, with (nominal) prices ranging from $875 to $2,016 per acre-foot.[82]

Larger lots of water rights tend to bring higher unit prices than do smaller lots because of the high costs of transacting water rights transfers in the Truckee Meadows. Frequently it is unclear whether land that was subdivided from another parcel that had an original water right decree retained any of the water right. Lengthy and sometimes expensive title searches are often necessary to prove ownership of water rights before they can be transferred. According to Sierra Pacific, the total cost for the title search, the payment of filing fees, and other costs for transferring a water right may be $1,000 per transaction or more.

A survey conducted in March 1985 by the Public Service Commission found that of the 32,000 acre-feet of water rights identified as subject to SB 323 acquisition, about 16,000 acre-feet were in blocks of less than 10 acre-feet and were the most likely candidates for purchase. The other 16,000 acre-feet involved blocks of 10 acre-feet or more, of which perhaps a dozen holdings were in excess of 100 acre-feet each. Of these 16,000 acre-feet of larger holdings, about 8,000 acre-feet were being retained by developers who wanted them for building projects. The remaining 8,000 acre-feet were held by owners who were willing to sell but were holding out for a higher price. Of a dozen interested sellers who were contacted with offers of $1,000 to $1,100 per acre-foot, none accepted. Four counteroffers were given ranging from $1,750 to $2,000 per acre-foot.[83]

Reno, Sparks, Washoe County, and Sierra Pacific have agreed to offer landowners $422 per acre-foot for their water rights under the SB 323 acquisition program. The price is based on a market value for the rights of $1,500 per acre-foot, less all transactions costs. Sierra Pacific leases the water rights from the cities and county for $422 per acre-foot, plus the costs to the local governments of handling the rights. When the water rights are applied towards a new development, Sierra Pacific passes to the new user its costs of acquiring the water right plus the expenses incurred in doing the title work on the transfer.[84]

As of the end of 1986, the program of acquiring water rights under SB 323 had met with only limited success. Sparks had purchased about 50 acre-feet of rights, and Reno about 325 acre-feet. Most of the potential sellers of water rights contacted by the cities had either failed to respond or had rejected the offer. Apparently there are two reasons for the general lack of response to the program. First, many holders of water rights have resisted selling their rights in the belief that prices will rise significantly in the future. The second is that several private water brokers operating in the Truckee Meadows have been outbidding the cities. Typically, the price offered by the brokers ranges between $600 and $800 per acre-foot, less a brokering fee. The brokers assemble several small water rights, each one as small as an acre-foot or less, into a package for resale to a local developer. The price for these brokered packages of urban water rights has exceeded $2,000 per acre-foot.[77]

Sierra Pacific is actively considering various market and nonmarket alternatives for acquiring additional water rights from sources outside the Truckee basin. The market alternatives include buying surface water rights in Sierra Valley, California, and groundwater rights in Warm Springs and Honey Lake, Nevada. Ranches in Sierra Valley are irrigated by surface water rights from a number of sources, including the Truckee River. Sierra Pacific has considered purchasing land with water rights at prices up to $2,000 per acre. Because Truckee River water rights tend to be spread relatively thinly over many acres, the company would have to purchase large parcels of land from dozens of different owners to secure an adequate supply of rights. The high cost of the water rights—in excess of $2,000 per acre-foot, not including pumping costs—local opposition to the purchase, and uncertainty over the legal implications of transporting water across the state line, have diminished interest in this particular alternative.[70, 85]

A more attractive market alternative for Sierra Pacific is the acquisition of groundwater rights in distant basins. The company is considering two different purchases, one for between 3,000 and 4,000 acre-feet of water rights in the Warm Springs area, 19 miles from Reno, and another for between 10,000 and 14,000 acre-feet in the Honey Lake area, 35 miles from Reno. Prices, which currently are still under negotiation, will probably fall bet-

ween $500 and $600 per acre-foot for rights in the Honey Lake area, and between $1,000 and $1,200 per acre-foot in the Warm Springs area. Sierra Pacific is negotiating lower prices for these water rights than it is willing to pay for Truckee River rights because of the high cost of treating the groundwater and transporting it into the Truckee Meadows.[70]

To summarize, water prices and conditions for water transfer vary considerably in the Truckee River Basin of western Nevada. Sierra Pacific and the cities of Sparks and Reno are large market participants and exert some influence on water prices within their service areas. Transfer within the Basin are complicated by unresolved Indian water rights claims, separate federal decrees for management of the Truckee River and the Carson River, and ambiguities surrounding interstate transfer and transfer of water developed by Bureau of Reclamation projects.

GILA-SAN FRANCISCO BASIN, NEW MEXICO

Description of the Study Area

The market area studied in New Mexico is the drainage basin of the Gila River, including its major tributary in New Mexico, the San Francisco River. The Gila-San Francisco Basin is a federally adjudicated basin in southwestern New Mexico, bordered on the east by the Continental Divide and on the west by the State of Arizona. Most of the land area in the basin is comprised of the Gila National Forest and the Gila Wilderness, vast expanses of sparsely populated forest and chaparral environments at elevations ranging between 6,000 and 10,000 feet. In the southern and western portions of the basin, where most of the population and most private landholdings are concentrated, elevations are lower and forest gives way to grasslands and high desert. The major urban center in the area is the town of Silver City with a population of about 20,000. Silver City is just outside the Gila-San Francisco Basin, south and east of the Continental Divide in the Mimbres Basin. Towns within the Gila-San Francisco Basin are small and widely scattered. The principle settlements include Reserve and Glenwood in Catron County and Cliff and Redrock in Grant County. These areas are shown in figure 6. The predominant industries in the Gila-San Francisco Basin are mining and ranching. Irrigated crop farming has been on the decline for many years. Since the late 1960s and early 1970s a number of vacation and retirement homes have been built in the vicinity of the Gila National Forest.

About 31,000 acre-feet of groundwater and surface water rights are held in the Gila-San Francisco Basin, roughly 6,500 acre-feet in the San Francisco portion of the basin and 23,500 acre-feet in the Gila portion. The rights in the San Francisco portion are used almost exclusively for irrigation and domestic purposes. The rights in the Gila portion are divided up as follows. Silver City holds over 1,300 acre-feet of water rights of which it is permitted to export the consumptive use portion, or about 800 acre-feet, to the Mimbres Basin. Mining companies hold about 11,800 acre-feet of rights, but their level of consumptive use is considered to be high so the quantity they are permitted to pump is less than this. The remaining 10,000 acre-feet of rights in the Gila sub-Basin are held by households, and irrigators.

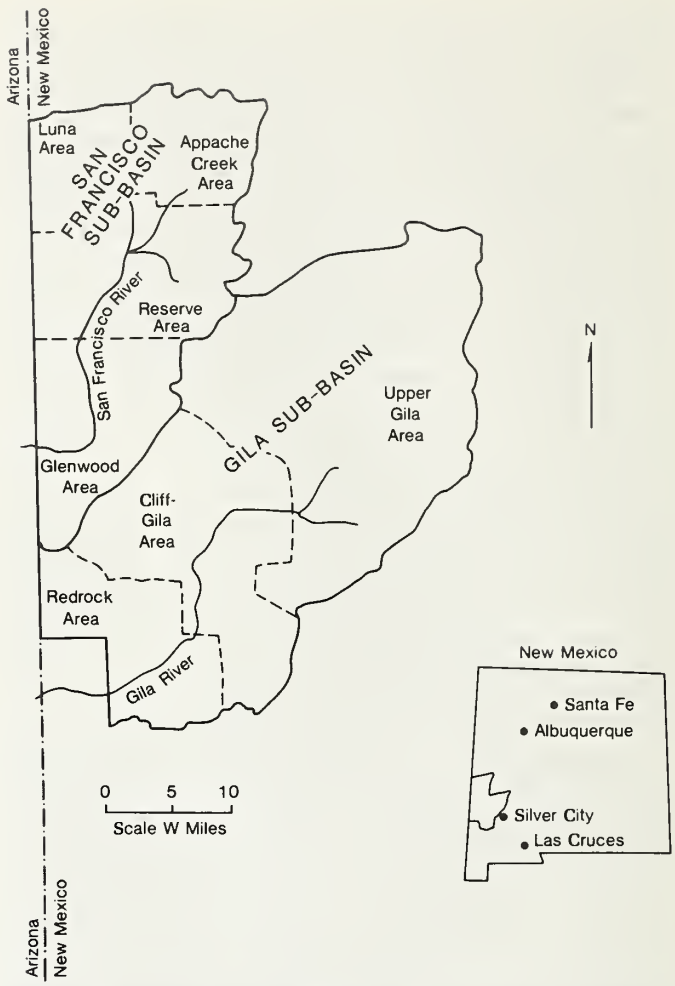

Figure 6.—Southwestern New Mexico: The Gila-San Francisco Basin.

Much of the water used in the Gila-San Francisco Basin comes from surface water sources, but groundwater pumping is also extensive. Surface water rights on the Gila and San Francisco rivers and on tributary streams are usually supplied by small private ditch companies. A large block of both surface and groundwater rights is used by the Phelps Dodge copper mine, near the town of Tyrone. The Boliden copper mine, which is still under construction, will use groundwater exclusively for its operation. Silver City and a few other small towns and residential subdivisions operate water treatment and distribution systems that also depend entirely upon groundwater. Most other domestic and commercial water users operate their own private groundwater wells.

Water Laws and Institutions

Virtually all groundwater and surface water rights in New Mexico are subject to the legal doctrine of prior ap-

propriation. A comprehensive administrative water code, passed by the territorial legislature in 1907 and adopted by the newly constituted state government in 1912, remains the basic surface water law of New Mexico today. Groundwater was first regulated in 1931.[86]

All surface waters and most groundwater in New Mexico are administered by the State Engineer. The State Engineer's responsibilities include all matters relating to the apportionment, transfer, and distribution of water. The State Engineer must approve all new appropriations of water for beneficial use as well as for changes in the place or purpose of existing uses. Jurisdiction of this office over the regulation of water rights includes all surface water rights and any groundwater in declared groundwater basins. The State Engineer designates a particular hydrologic region to be a declared groundwater basin when there is reason to believe that rapid development in the area might impair existing water rights. Most areas in the State are now included in the more than 30 declared groundwater basins.

Anyone in New Mexico who cannot be served by a municipal or domestic water service organization may drill a well for household use. A well that provides water for a single household and irrigates no more than 1 acre of land is usually exempt from state regulation. In declared groundwater basins, however, exempt wells must be registered with the State Engineer. Exempt groundwater rights are routinely granted by the State Engineer in most parts of New Mexico (the Gila-San Francisco Basin being an exception) for indoor and for outdoor household uses such as watering gardens, small orchards, and lawns, washing cars, and filling swimming pools.

In New Mexico, a water right is a property right and inherent in that ownership is the perogative to change the point of diversion, or place or use of the right. These changes, however, are governed by the overriding question of whether or not the change will impair existing water rights holders. A transferred right retains its priority date and its specific quantity of water so long as the right continues to be exercised.

Although the right to water is transferred automatically with the sale of the land unless reserved in the deed, a water right can be bought and sold separately from the land and sold for a new use in another area. The water withdrawn from use in the first area is adjusted for losses associated with the change of the point of diversion and credited to the water supply in the second area. The new owner is then allowed to draw from the credited supply.

Both groundwater and surface water rights can be sold or transferred. The transfer can be of both location and purpose. In some instances where surface water and groundwater resources are considered integrally related, the State Engineer may allow transfers from surface appropriations to groundwater appropriations on a limited basis. Under these circumstances, a new appropriation of groundwater may be permitted under the condition that the appropriation acquire and retire, that is, withdraw from use surface water rights in quantities sufficient to compensate for the effects of groundwater pumping.[87]

Water right owners can lease all or part of their right for not more than 10 years without affecting their original water right. New Mexico law states that a water right unused for 4 years is subject to forfeiture. A major benefit of leasing the right is that the owner avoids losing the right because of nonuse. The lease may be effective immediately or may be designated for future use in so far as that use does not accumulate or impair other water users.[87]

In the mid–1960s, the State Engineer formally declared the Gila-San Francisco Basin following the U.S. Supreme Court's adjudication of the lower Colorado River basin in *Arizona vs. California*.[88] The U.S. Supreme Court divided the Gila-San Francisco Basin into two separate sub-basins, corresponding to the respective drainages of the Gila and the San Francisco Rivers, and specified the maximum quantity of water that could be consumptively used from each of the two rivers before they flowed into Arizona. The court also divided each sub-basin into a number of areas, and specified the maximum number of allowable irrigated acres within each area. There are four areas in the San Francisco sub-Basin: Luna, Apache Creek, Reserve, and Glenwood. There are three areas in the Gila sub-Basin: Upper Gila, Cliff-Gila, and Redrock. Following the issuance of the U.S. Supreme Court's final decree in March 1964, the State of New Mexico adjudicated all water rights in the basin, and the process was completed by 1967. Finding that the total existing water rights were somewhat less than the limit imposed by the Supreme Court, limited filings for additional appropriations were allowed to continue for a short time. The basin has been closed to additional appropriations since about 1967.[89]

During the state adjudication proceedings in the mid–1960s, the State Engineer identified the exact acres of irrigated land, domestic households, and commercial enterprises that were putting water to beneficial use and had a valid claim to a water right. Commercial and industrial water rights were determined on the basis of their historical levels of use. Irrigation water rights (per acre) were determined on the basis of three different measures: the maximum allowable diverison right, in any 1 year; the maximum 10-year rolling average diversion right, and the consumptive use portion of the right. These measures vary throughout the Gila-San Francisco Basin but are uniform within each one of the seven areas. Domestic well rights are fixed at 3 acre-feet per year throughout the Gila-San Francisco Basin. There is no recognized consumptive use portion to a domestic well right.[89]

As a federally adjudicated basin, the Gila-San Francisco faces particularly stringent controls on the allocation, use, and transfer of its water rights. Appropriation of water rights for outside domestic use is not permitted even though this is routinely granted in closed groundwater basins elsewhere in New Mexico. Households with exempt groundwater wells cannot maintain lawns, gardens, orchards or otherwise use any water outdoors unless additional water rights are acquired to serve that purpose. The Gila-San Francisco has an active market for individual household water rights.[90]

Water rights transfers are permitted within the Gila-San Francisco Basin although they are subject to several restrictions. Water rights are not transferable into or out of the Gila-San Francisco Basin and are not transferable between the Gila and San Francisco sub-Basins. However, quantities of water equal to the consumptive use portion of any water right may be physically transported into or out of the basin or from one sub-basin to the other. Any diversion right in any quantity may be transferred within the same area. Only the consumptive use portion of a water right may be transferred between areas within the same sub-basin. Surface water and groundwater throughout the Gila-San Francisco Basin are considered to be interchangeable and the rights to one may be converted into the other—the point of diversion for a surface water right may be converted into a groundwater well, and vice-versa, usually without altering the quantity or priority of the right. In some cases where a surface water right is of very junior priority or is drawn from an intermittent stream where the full extent of the right is not generally accessible, the diversion right may be adjusted downwards when converted into a groundwater appropriation.[91]

Irrigation rights may be transferred for other purposes of use, but water rights assigned to non-irrigation purposes may not be transferred for irrigation use. In contrast, domestic well rights may be transferred anywhere within their respective sub-basins without changing the quantity of the right. Industrial water users who acquire irrigation rights are generally limited to divert no more than the consumptive use portion of the right.[89]

Water Market Activity

Water market activity in the Gila-San Francisco Basin has occurred since the basin was closed to additional appropriation in the mid–1960s. Thousands of acre-feet of water were transferred from irrigation to mining within the first few years, mostly in nonmarket transfers of water rights from a large ranch to a newly opened copper mine, both of which were owned by the Phelps Dodge Corporation. The ranch and its water rights had been acquired and developed by Phelps Dodge before the closing of the basin. The Phelps Dodge development holds over 11,000 acre-feet of water rights, which is equal to about half of all the water rights in the Gila sub-Basin and over two-thirds of all the water rights in the Cliff-Gila Area. Nevertheless, the market for the remaining water rights has been very active, with most activity involving the trading of the remaining irrigation water rights in the Cliff-Gila Area. Buyers for the water rights in the Gila-San Francisco Basin include other irrigation users, individual households, the town of Silver City, and a few smaller mines and commercial enterprises. The major commercial-industrial buyer of water rights since the Phelps Dodge acquisitions has been the Exxon Corporation and its successor, the Boliden Minerals Company, which acquired several hundred acre-feet of water rights in the early 1980s for a new copper mine 20 miles north of Silver City.

In 1986 Phelps Dodge announced that it had purchased Kennecott's interest in the Chino mine in the Mimbres Basin, and that it planned to phase out its mining operations at its Tyrone mine in the Gila-San Francisco Basin. Approximately half of the more than 11,000 acre-feet of water rights owned by Phelps Dodge in the Gila-San Francisco will no longer be used for mining within 10 years, and within 20 years the mine will be shut down completely, freeing up all of the water rights for alternative uses. The mine has considered transferring some of its rights to domestic purposes on company land that may be sold for retirement homes, but it is unlikely that all or even most of Phelps Dodge's water rights could be used for that purpose. The future of the supply and demand for water rights over the next few decades in the Gila-San Francisco Basin is therefore highly uncertain.[92]

San Francisco Sub-Basin

Almost all water rights in the San Francisco sub-Basin are used for irrigation or municipal and domestic purposes. A few small mills and a small mine are the only commercial water users in the area. Market transfer of water rights did not begin in the San Francisco sub-Basin on a significant scale until the mid to late 1970s, about 10 years after they began in the Gila sub-Basin. Most transfers have been in small quantities of 3 to 6 acre-feet or less. Prices for water rights in the late 1970s were about $500 per acre-foot; prices rose to as much as $3,000 per acre-foot before leveling off. Prices have fallen below $1,500 per acre-foot since 1983, when a major flood washed out many irrigated lands and a number of holders of irrigation rights chose to sell their water rather than invest in reestablishing their farms.[93]

Gila Sub-Basin

A substantial portion of the water rights in the Gila sub-Basin are controlled by three major entities: the Phelps Dodge Corporation, the Boliden mining company, and the town of Silver City. The remaining water rights are distributed over many individual holders, mostly in quantities of less than 50 acre-feet. The most active trading has been in small quantities of rights, often 1 acre-foot or less of rights at a time. The earliest sale of water rights dates to 1966 when a parcel of water rights were sold for about $1,800 per acre-foot. Real prices for water rights increased steadily through the 1970s, reaching over $4,000 per acre-foot by 1980. Since 1980, prices generally have declined to a range of $1,500 to $2,500 per acre-foot.

Price increases in the Gila sub-Basin during the late 1970s may have been attributable to the entrance of the Exxon Corporation into the water market. In 1979 and 1980, Exxon negotiated with about 25 different owners of land and water rights for the sale of as much as 1,200 acre-feet of irrigation water rights for transfer to mining. Roughly half of the transactions involved the sale

of only water rights, and the other half involved the sale of land and water rights together. In 1982 Exxon sold to Boliden most of its assets, including much of the water rights.[94]

Exxon contracted to buy the land and water rights through 5-year, annually renewable options. Options prices for the properties varied between about $3,300 and $6,600 per acre of land (about $2,000 to $4,000 per acre-foot of water at a rate of about 1.6 acre feet per acre). Annual payments to keep the option contracts current ranged from 6% to 10% of the option price. Generally these payments were not credited against the option price. In a few cases, a down payment in the first option year equal to about 20% of the option price substituted for annual payments. Some options were exercised as early as 1981, but most sales were not concluded until late in 1984. Two or three options were cancelled.[94] Exxon negotiated each option contract separately. There appears to be no direct correlation between either the option price and the size of the sale, or between price and the inclusion or exclusion of appurtenant land along with the water rights.

Water Leasing

Rental price data from 1963 to 1983 were collected on four leases in the Gila sub-Basin and on one in the San Francisco sub-Basin. Prices ranged generally between $100 and $250 per acre-foot with no evidence of any long-term trend either up or down. Rental prices for water in the Gila-San Francisco Basin appear to stand at roughly 10% of the current sales price for the rights.

Water Rights Acquisition by Silver City

Silver City owns water rights in both the Mimbres and Gila-San Francisco Basins. Most of the rights were appropriated and developed at a very low cost, but some were purchased at high market prices. Until 1982, nearly all of the water rights owned by Silver City were concentrated in two groundwater wellfields: the Franks field in the Gila-San Francisco Basin and the Woodward and Anderson fields in the Mimbres Basin. Since 1982, groundwater rights in two new areas in the Mimbres Basin have been acquired by the city.[95]

Rights to develop groundwater on the Franks Ranch were acquired by contract in 1945.[96] Silver City agreed to pay the landowners a rent of about $3.50 (nominal dollars, not adjusted for inflation) per acre-foot of water pumped and transported off the ranch. The contract had no termination date and there was no inflation adjustment clause. The price paid for the water has not been increased since it was established in 1945. A similar contract signed in 1954 allowed Silver City to develop the Woodward field.[97] The Woodward contract was amended in 1967 to increase the nominal dollar rental price from $3.50 to about $5 per acre-foot. Silver City has the right to pump and transport about 1,500 acre-feet per year from Woodward Wellfield, approximately 800 acre-feet per year from the Franks Wellfield, and an additional 400 acre-feet per year from the Anderson wells.[98]

Additional groundwater rights have been acquired by Silver City in both the Gila-San Francisco and Mimbres Basins. All purchases of water rights in the Gila-San Francisco Basin have been in the Gila sub-Basin. In 1981 the city purchased 78 acre-feet of water rights with a consumptive use of 43 acre-feet at a cost of about $3,000 per acre-foot of transportable (consumptive use) water. In 1984, the city purchased another 131 acre-feet of transportable water at a cost of $2,900 per acre-foot.[99] In 1985, the city acquired 32 acre-feet of transportable water for slightly more than $2,200 per acre-foot. All of these water rights were successfully transferred to the Franks Wellfield, in the Cliff-Gila Area, and the water is being pumped over the Continental Divide into the Mimbres Basin. There have been two recent water rights acquisitions in the Mimbres Basin. In 1982, Silver City paid about $1,500 per acre-foot for 193 acre-feet of water rights.[100] In 1985, 1,433 acre-feet of water rights were acquired for about $2,200 per acre-foot.[95]

To summarize, water rights transfer in the Gila-San Francisco Basin can be readily arranged, with lower transactions costs than in many other areas studied. Silver City and the mines hold the majority of water rights in the basin, and the number of potential market participants is relatively small. The announced closing of the Phelps Dodge Mine has cast a cloud of uncertainty over the future supply and demand for water rights in the basin. Neverthless, market sales and rentals of water rights among irrigators and between irrigation and non-irrigation water users continue to occur.

LOWER SEVIER RIVER BASIN, UTAH

Description of the Study Area

The market area chosen for study in Utah is the Lower Sevier River Basin of west-central Utah. The Sevier River begins in the highland plateaus of southwestern Utah and flows north for about 150 miles before turning south and west for a short distance to terminate in Sevier Lake. The area lies within the sparsely populated, isolated, and extremely arid Sevier Desert. Average precipitation is less than 8 inches per year. The principal population center is the small town of Delta, with approximately 5,000 residents. It lies in the northeastern corner of Millard County, about 140 miles southwest of Salt Lake City. Other small towns near Delta are Hinckley, Sutherland, Deseret, and Oasis. Also included within the study area are the towns of Lynndyl and Leamington, located along the Sevier River 15 and 20 miles north of Delta, respectively. The lower Sevier River Basin is shown in figure 7.

Approximately 50,000 acres are irrigated in the vicinity of the northern bend of the lower Sevier River. Agriculture, the mainstay of the local economy, is the primary water user in the area. Alfalfa and alfalfa seed are the major products. A significant quantity of acreage is also

devoted to barley and other small grain crops. A major new water user in the area is the Intermountain Power Project (IPP)—a large, coal-fired, electric power generating facility—about 10 miles north of Delta. Currently under construction, IPP will retain several hundred permanent employees when it begins full-scale operations in 1987.

Four mutual ditch companies cooperatively manage most of the surface water supplies within the study area. The Delta, Mellville, Abraham, and Deseret ditch companies are collectively known as the DMAD companies. A fifth company, the Central Utah Irrigation Company, distributes water out of the Sevier River upstream from the DMAD system. The Gunnison Bend, DMAD, and Sevier Bridge Reservoirs operate on the lower Sevier River. Gunnison Bend, the smallest reservoir with a storage capactiy of 4,500 acre-feet, is owned exclusively by the Abraham and Deseret Companies. The DMAD Reservoir, with a capacity of 11,500 acre-feet, is owned by all four of the DMAD companies. Sevier Bridge, the largest reservoir with a storage capacity of 235,000 acre-feet, is owned jointly by the DMAD companies and the Central Utah Irrigation Company.[101]

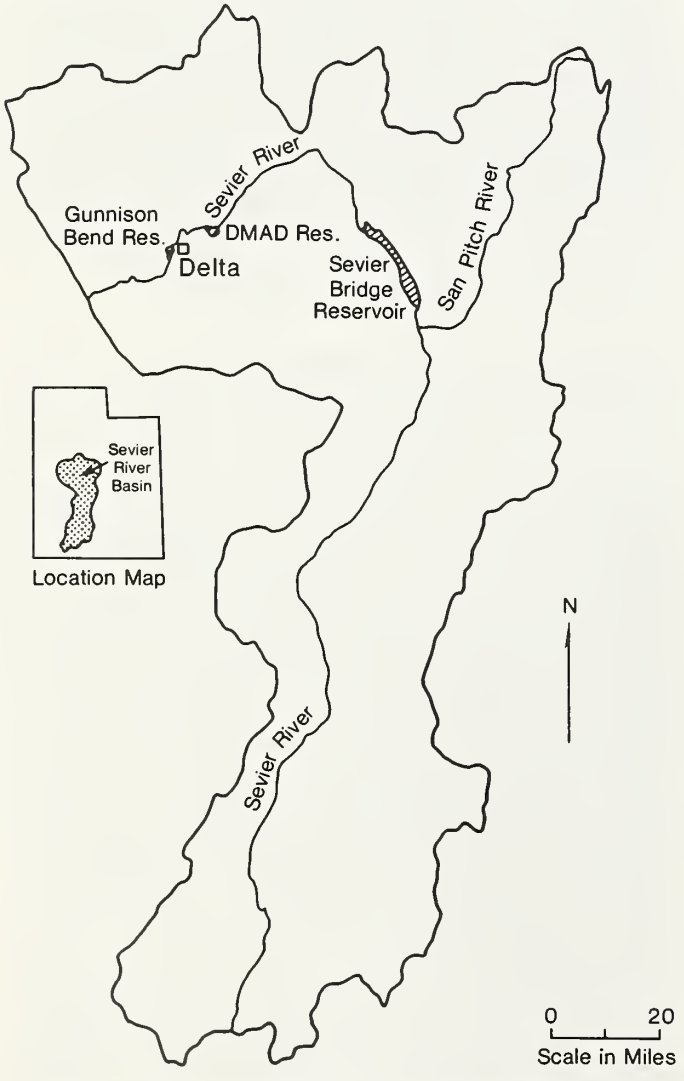

Figure 7.—Central Utah: The Lower Sevier River Basin.

On average, about 120,000 acre-feet of water per year are delivered through the DMAD system. Most of the supply comes from direct flows in the Sevier River and from storage water in the Gunnison Bend, DMAD, and Sevier Bridge Reservoirs. Supplemental water is pumped from several shallow groundwater wells jointly owned and operated by the DMAD companies. Groundwater is pumped into the river to maintain minimum flows and also to reduce salinity levels. As much as 28,000 acre-feet of groundwater per year may be diverted into the river although the volume pumped usually is much less.[102]

The high level of salinity in the Sevier River prevents the water from being used for human consumption. Groundwater quality, however, is generally good throughout the basin. Hence, groundwater is the only source of water for domestic, municipal, and most commercial water users. Groundwater is also used to supplement surface water supplies for irrigation during critical periods.

Water Laws and Institutions

The doctrine of absolute priorities was not followed in Utah because early Mormon leaders gave greater weight to proportionate sharing of water shortages. When rights to Utah streams were established, each claimant was assigned proportionate shares of the flow. The shares assigned to each canal were based on priority of appropriation—the canals that had first diverted water and put it to use in irrigation water were given preference over later canals—though this principle was far from absolute. Time priority was modified considerably by the apportionment of the variable water supply by fractions instead of by physical volume. In this way, the effects of drought were spread over all users instead of only the most junior appropriators.[103]

To prevent the over-allocation of water supplies, Utah instituted a system of primary and secondary rights. In general, primary water users are ensured adequate water supplies to meet all demands even during periods of drought, while holders of secondary rights may not always be able to take delivery of their prorated allocation. This division of water rights into classes was peculiar to Utah in the Western United States. This permitted more equitable sharing of the costs associated with drought than was possible in systems that used absolute time priorities.[103]

Groundwater rights and transfers are controlled carefully in the Delta-Lynndyl area. The groundwater basin has been closed to major additional appropriations since the late 1970s. Water rights of less than 2 acre-feet per year for private domestic use are the only groundwater appropriations still permitted.[104] All lands surrounding the town of Delta and lying east and south of the Sevier River are considered to be within a "high impact" part of the basin. This is where most of the area's population, growth pressures, and economic activity have been located, especially since the arrival of IPP. Groundwater rights transfers are permitted within and

out of the high impact area, but no water rights can be transferred into the area from surrounding areas. The State Engineer also distinguishes between shallow and deep groundwater wells when managing water rights. The best water quality is found in wells drawing from deeper groundwater aquifers. Transfers of rights are not permitted between wells that draw water from different hydrologic formations in the basin. High-quality groundwater within the high-impact portion of the basin is scarce and highly valued.[105]

Nearly all of the irrigation water used in Utah is distributed through organized irrigation entities, most of which were established by Mormon pioneers. The successors of these early cooperative organizations are called "mututal water companies" and are the most common type of private irrigation company in Utah. Water rights represented by stock in a nonprofit mutual irrigation company are not appurtenant to the land upon which the water is used. Individual stockholders are not subject to state laws regulating the beneficial use of water rights. They may own as many or as few shares of water stock as they wish, regardless of whether they own sufficient land on which to use the water. A farmer who has a right to more water than he plans to use in a given season or in a given crop rotation may rent his right to a farmer who wants it. An individual may own water stock without owning any land at all and rent out the entire portfolio of water rights every year. Conversely, a farmer may own land and own no water stock and rent the desired quantity every season. The only condition on the use of the water transferred is that it be used within the service area of the mutual stock company.

Water rights represented by mutual water stock can be transferred between farmers simply by transferring the stock. The transfer of stock representing water rights does not require administrative proceedings before the State Engineer to change the point of diversion or place of use of the water. Such proceedings are required in transfers of water rights not represented by mutual company stock. Water rights not represented by stock, are appurtentant to the land for which the appropriation was made, although they may be severed from the land and sold separately. Unless specifically reserved by the grantor, appurtenant water rights automatically pass with a sale of the land.[106] The transfer of water stock outside of the service area of the mutual stock company requires the filing of an application before the State Engineer requesting a change in the point of diversion. If such a change is not within the boundaries of the controlling irrigation company, an administrative hearing is required. However, such changes are usually allowed if they do not interfere with the rights of others.

Water rights in the lower Sevier River Basin were adjudicated under the Cox Decree of 1936.[107] Local mutual ditch companies had already been in existence for many years. Water rights were assigned to each water company on the basis of current use and not prior appropriation. The timing and distribution of proportional shares of the streamflow were specified, along with formulas for prorating water supplies to all users during drought years.

Water is allocated by the governing boards of each of the DMAD companies, who meet each spring to determine the water "credit" to be issued on each share of outstanding water stock. The size of the credit is based on projections of yields from storage and flows along the lower Sevier. Stockholders are given water accounts that function much like a bank account. Water may be withdrawn from the account at any time during the irrigation season, or deposits may be registered by transferring water from another stockholder's account. DMAD permits owners or renters of company water to carry over any part or all of their holdings to the following irrigation season, less 20% to account for evaporation losses. Water may not be carried over for more then a single year. This option enhances flexibility for the individual farmer in managing his water resources, although there is some risk involved in carrying over water rights. If the storage capacity of the reservoirs is reached at the beginning of the following irrigation season, all carryover accounts are erased and water credits are reissued to all stockholders based on the total available water supply.[108]

Water transfers among water users in the DMAD service areas have been common for several decades. Sales and rentals of water among shareholders within individual companies have occurred since the early 1900s. In about 1950, the DMAD governing boards instituted an agreement to permit informal seasonal transfer (rental) of water between companies. Normally, the transfer of water among different mutual stock companies would require proceedings before the State Engineer. In this case, however, the State Engineer waived the proceedings because the DMAD companies are located near the end of the Sevier River where no downstream users could be impacted by any transfer or change in use of the water in the system.[109]

Seasonal intercompany water transfers among the DMAD companies continued without formal legal sanction until 1980. In 1980, upon approving the change application to transfer DMAD and Central Utah company water to IPP, the State Engineer finally declared that the points of diversion and place of use for the four DMAD companies were interchangeable.[110] Multiple use permits were granted for all the water rights transferred, allowing the seasonal rental of water unused by IPP back to irrigators. The DMAD company secretary works closely with the River Commissioner for the lower Sevier River to ensure that all water accounts "balance," and that the total appropriations by each of the DMAD companies does not exceed the legal limit of its prorated shares.[102]

Rentals are handled in the same fashion whether the renter wishes to transfer water to land within the same water company service or to land within the service area of another DMAD company. The prospective renter submits a card describing the requested transfer to the DMAD company secretary. Provided that sufficient water credit is left in the individual's water account for that season, the quantity of water to be rented is debited against the lessor's account and credited to the lessee's account. Water is usually rented in acre-foot units, but

the parties may sometimes choose to rent shares of water stock instead. Individuals renting water stock have the option to use the water in the current irrigation season, or to take the risk of carrying the water over into the next season.[101]

Water Market Activity

Management of the DMAD companies has been highly integrated since at least the early 1960s. There is no longer any practical distinction between owning shares of stock in one company or another. Although the historical average yield per share of stock differs, on a per acre-foot basis the market price for water represented by a share of stock is similar among the four companies. In 1985, the price for water represented by any one of the companies' stock was approximately $350 per acre-foot.

Water rights prices between 1974 and 1985 exhibit no trend either up or down except for a brief period between 1979 and 1982, when the introduction of the IPP to the Delta area caused a speculative boom in land and water rights. IPP paid over $2,400 per acre-foot for one large package of groundwater rights and water company stock. Prices exceeded $1,000 per acre-foot for other sales of water stock occurring at about the same time. By about 1982, the speculative bubble subsided and water stock prices began to return to their former levels.

The package of 45,000 acre-feet of water rights purchased by IPP for its power generating station was composed of 5,400 acre-feet in groundwater rights and 39,600 acre-feet in water company stock. The stock comprised roughly 20% of all the water rights owned by the DMAD companies and 85% of the rights owned by the Central Utah Irrigation Company.[111] Many different sellers were involved in the transfer, and most of the water rights were sold in relatively small lots. There were 565 individual contracts signed to purchase water company stock, averaging about 60 acre-feet per contract. Another 31 contracts were signed for the sale of groundwater rights with an average of 174 acre-feet per contract.[112]

Water rights were transferred to IPP via a seller's collective called the Joint Venture. The Joint Venture was formed after a core group of organizers announced IPP's interest in purchasing water rights and advertised for a collective bargaining coalition in the local newspapers in 1978. Anyone owning stock in the DMAD or Central Utah companies or groundwater rights in the Delta or Lynndyl areas was invited to participate in the sale to IPP. Participants were allowed to offer prorated quantities of water rights for sale, established as fixed proportions of water rights owned by each prospectve seller.[113] Individuals were free to offer more than their assigned quantity of water rights for sale, but they had to find other participants who were willing to reduce their allotments by a compensating amount. This led to the development of an active market in sales options. Option prices for the sale of water rights to IPP through the Joint Venture are reported to have sold for as much as $650 per acre-foot in the late 1970s.[114]

Groundwater rights in Utah are not quantified volumetrically; rather, they are specified in terms of a flow rate. In order to determine how much groundwater could actually be transferred to IPP, the State Engineer had to determine the consumptive use of groundwater in the areas where the sales were to take place. The State Engineer issued an interlocutory order (the order is not final, pending further hydrologic studies) stating that the consumptive use portion of the groundwater rights in the affected areas was only about half of the average volume diverted.[114] IPP had specified in the negotiations that it would only pay for the volume of water that was *transferable*, not the total volume of the rights. Option prices for groundwater rights reportedly fell by at least half, to about $300 dollars per acre-foot. Nevertheless, sufficient groundwater water rights were still offered to complete the water rights package wanted by IPP. No final order has yet been issued by the State Engineer. If the interlocutory order stands, the farmers who sold groundwater rights to IPP will have to retire twice as much irrigated acreage as they originally intended. The Joint Venture is prepared to sue the State Engineer if the order is upheld.[114]

IPP bought groundwater rights for two different purposes. One was to supplement the supply of surface water rights for its power generating operations. The 5,400 acre-feet of groundwater rights acquired for this purpose were purchased from the Joint Venture for the same unit acre-foot price as was paid for the water company stock. A second bundle of groundwater rights were purchased from private individuals to create a "water bank" for the town of Delta to support urban growth.[115, 116] New developments in the Delta service area must now either provide sufficient groundwater rights to transfer to Delta or pay a raw water fee in order to get hooked up to the town water system. The fee, $1,000 per acre-foot, is based on the average nominal price paid by IPP for the water rights bank, $960 per acre-foot, plus a $40 handling charge. As projects are built and the new users pay Delta for withdrawals from the water bank, Delta reimburses IPP for the cost of acquiring the rights.[116]

Real prices for groundwater rights have fallen since 1980. Excluding IPP's purchases from the Joint Venture, prices in 1980 and 1981 ranged between $900 and $1,200 per acre-foot. Since 1982, groundwater rights located near Delta have sold for about $700 per acre-foot. Groundwater rights located outside of the high-impact portion of the Delta area basin range in price from $300 to $500 per acre-foot.[117]

Shortly after concluding the sale of the water rights, IPP announced that it would scale back the design of the facility from four power generating units to only two. IPP now expects to use only about 20,000 acre-feet of its 45,000 acre-feet of water rights. The excess water rights will be retained in anticipation of future plant expansion. Unused water supplies will be rented back each year to individual water users in the irrigation companies. Traditionally, water has been rented for one season at a time in the lower Sevier basin. Since IPP has such a large quantity of water rights that will not be used

in the foreseeable future, the company is considering making arrangements for long-term leases of some of the water.[118]

IPP has become the dominant renter of water in the DMAD system. The long-term impact of IPP on the water rental market may not be known for several years. In 1979, a relatively dry year, DMAD water rented for nearly $30 per acre-foot. In 1980, the year before IPP began renting water, flows in the Sevier River were high and the real price of rental water subsequently fell to less than $8 per acre-foot. During the following 2 years flows were closer to the average, but real rental prices only rose slightly to about $9 per acre-foot. Coinciding with the IPP purchase, the Sevier River system entered upon an unprecedented wet cycle that persisted into 1985. The rental market resumed in the middle of the 1986 irrigation season, but water was still abundant, trading activity light, and rental prices low.

Water rental prices between 1948 and 1982 ranged roughly between about $7 and $75 per acre-foot. Real prices generally increased from a range of $7 to $20 per acre-foot in the late 1940s and early 1950s to a range of $20 to $75 in the mid–1950s through the mid–1960s. Since the late 1960s the rental price has declined again to a range of $8 to $25 per acre-foot. Rental prices have varied tremendously from one year to the next. Between 1953 and 1954, for instance, rental prices increased from $11 per acre-foot to $26. Between 1967 and 1968, real prices fell from $50 per acre-foot to $24. During the 1986 season, prices ranged between $3 and $5 per acre-foot.

A study of water rental price behavior conducted between 1946 and 1963 in the Delta area indicates that fluctuations in water rental prices are strongly related to the hydrologic cycles of the Sevier River.[119] Rental prices tend to be high in dry years when water supplies are low, and low in wet years when water supplies are high. Rental activity is busiest during the spring and summer months, and the volume of rentals varies with the total supply of water. The rental volume is lowest in very wet years because supplies are more than adequate for most stockholders and demand for additional water is low. The volume of water rented is also low in very dry years when supplies are scarce and prices are high enough to cut short demand for supplemental water. Rental activity appears to be the highest in moderately dry years when the demand for water is strong and the supply is more flexible.

To summarize, market activity in Utah's Lower Sevier River Basin demonstrates how water rights represented by mutual water company stocks can be transferred with minimal transaction costs. The entrance of Intermountain Power Project into the market, first as a major water buyer and now as the principal lessor of water to irrigators, is an interesting case study of a dominant market participant's impact on water prices and transfers. The Utah market also provides an opportunity to observe both sales and rentals of groundwater and surface water.

MARKET PRICES AS MEASURES OF VALUE

A measure of value used by a public agency to evaluate supply augmentation projects should fully reflect potential beneficiaries willingness to pay for incremental increases in the available water supply, as well as any positive or negative side effects (externalities) of the supply increase on individuals or groups in the region. This section outlines economic concepts helpful in understanding the role of market prices as measures of value and identifies three sources of concern: (1) limitations economic theory places on prices as measures of value; (2) the effect of specific market characteristics on prices as measures of social value; and (3) practical considerations that would confront an agency seeking to use market prices as measures of value. These concerns are discussed, along with their implications for using market prices to value incremental flows from public lands.

THEORETICAL CONCERNS WITH PRICES AS MEASURES OF VALUE

Prices in a perfectly functioning competitive market will reveal buyers' willingness to pay for the marginal (the last) unit purchased. Figure 8 shows hypothetical urban, agricultural, and aggregate demand functions for water at a fixed point in time. The downward slope of the curves reflects the economic concept of diminishing marginal utility. The value of the first units of water made available is high, as water in excess of precipitation is essential to economic activity in the arid West. However, as more units of water become available to a particular water user, that individual or firm is willing to pay less and less for each increment of water. Different types of water users have somewhat different demand curves. Urban residents (illustrated by D_U in figure 8) attach a higher value to the small quantity of water they use than most farmers would be willing to pay for that same quantity of water. However, irrigated agriculture also has a downward sloping demand curve for water D_I in figure 8). The negative slope reflects the fact that the first quantities of water available to a farm are the most valuable because they will be applied to crops for which the highest returns can be obtained. Additional water will be applied to the next most profitable set of crops, and so on. The aggregate water demand curve, D_A, is the horizontal summation of the agricultural and urban demand schedules. Given a supply curve represented by S_1, the market clearing price for water occurs at P_1. Note that the market price lies *above* the unit value water users would place on additional supplies if the supply curve shifted out to S_2. Willingness to pay for units of additional water could be substantially lower than P_1, depending on the shape of the total demand curve to the right of Q_1. As figure 8 illustrates, even in a perfectly competitive market, observed prices serve only as an upper bound for what current market participants might be willing to pay for additional supplies.

Figure 8 portrays water demand, supply, and price formation in a static framework. As population and income levels grow or agricultural commodity prices and production technologies change, demand and supply curves shift and new prices evolve. As these changes occur, prices emerging from previous demand and supply relationships could either overestimate or underestimate the

marginal value of water supply increases in the future. A more complete discussion of demand and supply conditions surrounding water in the Southwest can be found in Kelso et al.

In a smoothly functioning competitive water market, price is uniquely determined by convergence of buyers' and sellers' marginal values. However, water transactions do not take place in well-functioning competitive markets that generate prices fully reflecting the costs and benefits of transactions to all parties affected. In actual market transactions, a negotiated price will lie between the buyer's maximum willingness to pay for units of water exchanged and the minimum amount the seller is willing to accept in payment for water transferred. In a transfer from a farmer to a city water supply organization, for example, the lowest price acceptable to a farmer (the reserve price) would be based on the value of the marginal product of water in agriculture if only a portion of the farm's rights are sold or the value of average product if rights for the whole farm are sold. Also, farmers may view water rights as an appreciating asset and add speculative value to their reserve price, as Gardner and Miller find in analysis of Colorado water market transactions.[120]

Young notes that only a small fraction of agricultural water use is influenced by urban demands expressed through market processes.[121] Much irrigation water is supplied under public project contracts and is insulated from market pressures because most public project water is not readily marketable. Also, irrigation water supplies may not be attractive to urban buyers because they can be expensive to deliver and treat for municipal uses in comparison with alternative sources of supply. For all these reasons, market prices will typically lie above the marginal value of water in irrigated agriculture.

A distinction must be drawn between private and social measures of value. Under competitive market conditions, price negotiated between a buyer and a seller of a water right reflects the marginal value of the units of water exchanged to each party and thus can serve as an indicator of water value for the agents involved in the transaction. A social measure of value, however, also takes into account impacts on parties affected by the transaction who were not part of the price negotiation process. This could include neighboring well owners whose pumping costs are adversely affected, fishermen whose trout habitat is disrupted, future water users whose access to water will be curtailed because of current market activities, or local goverments which experience declining tax bases when water sales shift resources out of the local economy.

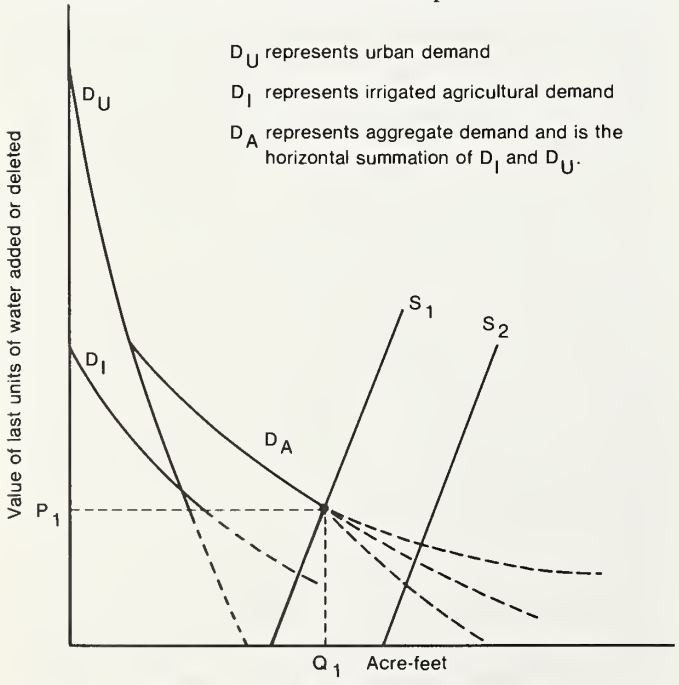

Figure 8.—Water demand and supply.

MARKET CHARACTERISTICS AND PRICES AS MEASURES OF VALUE

Several market characteristics may prevent observed prices from representing social values; e.g., inequities, externalitites, imperfect competition, and uncertainty. Table 1 describes these characteristics and provides examples of each in the market areas studied.

Market prices may arise from a distribution of income and access to water that is considered inequitable. Prices generated in water markets inevitably reflect the prevailing income distribution and allocation of water rights. In a market setting, water users with more water and dollars have more "voice" in the marketplace than those with less water and money. In public elections each citizen receives one vote with which to influence the outcome of the election. In water markets, participants "vote" with their dollars and their water rights to influence the outcome of the market allocation process. Therefore public agency use of market prices to measure water's value may not be consistent with distributional objectives of water policy. Controversies regarding Indian water rights in the Southwest illustrate the need for attention to equity issues.

Three additional concerns relate to efficiency issues connected with prices as measures of value: (1) if water transfers positively or negatively affect third parties and these effects (externalities) are not taken into account in market decisions, then prices will not reflect full social values. Prices observed in water markets give the upper bound of an increment in supply only to the extent that those prices represent all uses of the water affected by the increment in supply. Prices are unlikely to be generated for instream water uses, such as recreation, hydropower production, and provision of aquatic habitat; (2) if one or more water users, suppliers or government agencies can significantly affect prices or restrict transfers (imperfect competition) then observed prices may deviate from maximum willingness to pay for marginal units of water; (3) lack of hydrologic and legal information regarding future water availability and transfers can distort market prices, as can uncertainty regarding future government programs and policies. Uncertainty reduces willingness to pay when individuals cannot ascertain what legal rights and restrictions are associated with a particular water right or transfer.

Table 1.—Water market characteristics, definitions and examples.

Imperfect competition and market restrictions: Market participants or public agencies restrict price levels and other conditions of market transfer, and observed prices may reflect these restrictions. *Example*: In northeastern Colorado, municipal water departments and water districts are under public pressure not to profit from renting their unused water supplies back to farmers. Most renters simply rent the water at cost, which may be well below the market clearing price.[a]
External effects of market activities (externalities): Market prices do not take into account the values of parties external to the price negotiation process or impacts on third parties. *Example*: In the Lower Sevier River Basin of Utah, changing water use patterns by the Intermountain Power Project will improve water quality for irrigators by reducing salinity in the river.[b]
Uncertainty: Uncertainty regarding future water supplies, demand, and the legal framework that governs water transfers will affect market decisions and observed prices. *Example*: The legal framework that governs water use and transfer in Arizona is still evolving, and important legal issues related to transfer of specific types of water rights have yet to be clarified.[c] Significant quantities of additional water supplies were denied to users in Nevada when the federal government decided to use Stampede Reservoir for maintaining fish habitat in the Truckee River instead of allocating the water for consumptive purposes. The ensuing scramble for alternative sources of water has helped push water rights prices to unprecedented levels.[d]
Equity and conflict resolution: Economic and legal barriers to market participation can create inequitable access to water. Water allocation decisions may serve as a form of conflict resolution and be made on political rather than economic grounds. Market prices may not fully reflect distributional and political considerations. *Example*: Many traditional instream uses of water have never been legally recognized and are increasingly threatened by increased consumptive uses of offstream. In southwestern New Mexico, unique riparian habitat in the Gila River is endangered by a proposed dam.[e] Pyramid Lake Indians in Nevada have no water rights to protect their traditional fishing grounds, and have resorted to extensive litigation to maintain minimum flows in the Truckee River system.[d]

[a]*Howe, Charles W., D. Schurmeir, and W. Shaw. 1982. Innovations in water management: An ex-post analysis of the Colorado-Big Thompson Project and the NCWCD. University of Colorado, Boulder, CO.*

[b]*Clark, Rodney. 1979. Intermountain power project water supply acquisition. Presented to the Intermountain Power Association, Salt Lake City, Utah.*

[c]*Bush, David B., and Bonnie C. Saliba. 1987. Dealing for water in the west: Pots of gold or wooden nickles? Department of Agricultural Economics working paper. University of Arizona, Tucson, AZ.*

[d]*Personal conversation with Rick Moser, Water Resources Engineer, Sierra Pacific Power Company, Reno, Nevada. 1985.*

[e]*Personal conversation with George Jackson, Real Estate Broker, Silver City, New Mexico. 1987.*

Equity and Conflict Resolution

In market areas where Indian nations hold a significant portion of water rights, absence of Native American participation in water market activity implies that the values of a substantial water interest group are not reflected in market prices. In any region where potential beneficiaries of augmentation are not active market participants, information regarding yield augmentation impacts on nonmarket participants will be necessary for a thorough evaluation of supply augmentation proposals.

Allocation of water to a specific area or group may have political and conflict resolution value to a region, above and beyond measurable economic benefits. Both the Central Arizona and the Central Utah Projects are viewed by some observers as devices for resolving conflicts among water users rather than as economically rational water supply augmentation measures.

Water transfers are often a lower cost alternative for providing water to new users. However policies that encourage market transfers from one sector to another (agriculture to cities, for instance) may involve political and social costs as income, employment, and tax base shift with water from one sector to another. Decisionmakers sometimes implement supply augmentation projects when water transfers might be a lower cost alternative for providing water to expanding uses. In these situations it could be inferred that the conflict resolution and other political values stemming from supply augmentation are perceived to justify the project.

External Effects of Market Activities

Laws and institutions in each market area seek to minimize the impact of water transfers on neighboring water users. Examples of rules that seek to prevent externalities include well-spacing regulations, requirements for consent by others in the affected watershed to proposed transfers, and requirements for engineering studies to demonstrate no third-party effects. Such rules are designed to protect traditional water uses by focus-

ing on return flow levels for surface water or drawdown for groundwater. They are less effective in preventing impairment to nonconsumptive uses of surface water, such as instream recreation. Market prices will not reflect negative side effects of transfers on uses which are not represented in market activities.

External beneficial effects of market activity on third parties do occur. For example, transfer of Colorado-Big Thompson units from irrigators to cities (which have lower consumptive use and are upstream of irrigated areas) has increased return flows for users downstream of the cities—including the irrigators who sold the rights to the cities in the first place. Positive side effects of water transactions may not be reflected in market prices. In valuing incremental flows from public lands, the degree of negative or positive effects of market activity needs to be examined, and observed market prices adjusted accordingly for use as measures of value.

Imperfect Competition and Market Restrictions

The market areas studied differ tremendously in numbers of buyers and sellers, relative influences of particular buyers and sellers, frequency of transactions, and degree of institutional restrictions on market activities. In both the Truckee River and the Lower Sevier River Basins large utility companies are dominant market actors and influence water rental and sales prices. In the Gila-San Francisco Basin and in the neighboring Mimbres Basin a few large mining companies own the largest blocks of water rights. It is not possible to identify precisely the effects dominant buyers or sellers have on prices. In some cases, they seem to function as price setters, giving price signals that are followed by other market participants. However, in the Truckee River Basin, efforts by Sierra Pacific in the early 1980s and current efforts by the cities of Reno and Sparks to purchase water rights at reduced prices have not noticeably affected market prices. With respect to implications for using market prices as measure of value, the presence and degree of imperfect competition needs to be evaluated on a case-by-case basis. If there is a consistent and significant discrepancy between prices emerging from negotiations involving the large volume buyers and sellers and negotiations that do not involve them, then further study will be necessary to determine reasons for the discrepancies and to identify which market prices (if any) are an appropriate reflection of water values.

The numbers of buyers and sellers and frequency of transactions affect the quantity of price data available. A specific price may be a more reliable measure of water value if there are a large number of transactions that confirm that price as typical. In a region with sporadic market activity and spotty price data, use of market prices should be supplemented with non-market information to estimate water values for water.

The seven market areas studied differ tremendously in institutional restrictions on market activity. For instance, in Utah water rights represented by irrigation company stock are readily transferable within the service areas of the DMAD companies with minimal paperwork and administrative proceedings, and need not be tied to a specific parcel of land. In contrast, some water rights in Arizona may be transferred only under carefully specified conditions, and irrigation rights cannot be transferred separately from the land.

Within any given market area, different water rights may be subject to different guidelines on change of ownership, purpose of use, location, and leasing. For example, Type II rights in Arizona may be transferred separately from the land to which they are appurtenant but must be transferred in their entirety so that a right holder may not sell only a portion of his rights. Arizona irrigation rights are strictly appurtenant to land but farmers may sell portions of (rather than the entire quantity of) their land and irrigation rights. Colorado transmountain diversion water from the Colorado-Big Thompson project is much more transferable than transmountain diversion water from the Frying Pan-Arkansas Project in the southeastern part of Colorado. Local transfers of Lower Sevier River surface water rights in the form of mutual company stock transactions are less complicated than transfers of groundwater rights in the Lower Sevier Basin.

These examples illustrate the fact that generalizations among areas regarding marketability of water rights must be made with caution. Within each state studied there are varying degrees of restrictions on market activity that apply to different kinds of water rights. Similarities among state water laws are found in the themes of water's appurtenancy to land, requirements for beneficial use, and prior appropriation. It is not the overiding legal doctrines that differ greatly across states but rather the interpretation and implementation of those doctrines as manifested in local water management institutions.

Legal, Hydrologic, and Economic Uncertainty

All markets studied are characterized by varying degrees of uncertainty and access to market information. Arizona and Utah markets provide contrasting examples of this. The Arizona Department of Water Resources keeps records of Type II water rights holders, which may help buyers and sellers to find one another, though there is no central clearing house for communicating bids and offers. Recorded transfers are few in number relative to other water markets. Because Arizona water markets are still in the early stages of development, potential buyers and sellers have little experience and historical information on which to base expectations about water values and market processes. In the Lower Sevier Basin irrigation company records provide information on ownership and rental patterns, and company offices have served as informal clearinghouses—helping prospective buyers, sellers, and renters to find one another. Historical records on the hydrologic cycle of the river system, along with careful reservoir management, give water users a basis on which to form expectations about future water flows and availability.

Hydrologic uncertainty is inevitable in surface water markets as supplies cannot be predicted each year until winter snowpacks are studied to predict spring runoff and river flows. This uncertainty is mitigated to varying degrees by storage facilities and interbasin diversion projects. One of the principal objectives of the C-BT Project is to reduce uncertainty associated with erratic and seasonal surface water flow. Uncertainty affects groundwater markets when there is incomplete knowledge on aquifer capacity, rates of overdraft, and other factors that affect expectations regarding the long-term expense of pumping groundwater.

Hydrologic uncertainty affects how much individuals are willing to pay for a water right. Senior surface water rights are generally more valuable than junior surface water rights that are more vulnerable to seasonal and year-to-year variations in flow. For example, Sierra Pacific made price offers for water rights based on their priority dates—with the most junior rights valued 25% less than the most senior rights.[77]

Uncertainty regarding future water demand and the health of regional economies and water-using industries is inevitable and affects market prices. Water prices rose sharply in the Lower Sevier Basin with expectations that Intermountain Power Project would build a large power plant in the area, bringing increased population and water demand. Prices dropped when the power plant and development boom turned out to be much smaller than anticipated. The short run marginal value of water to irrigators rises and falls with crop prices, and the interest of mines and other industries in acquiring water rights fluctuates with the profitability of those industries. Economic uncertainty affects market prices because prices reflect economic expectations and conditions. With respect to valuing water, this implies that one needs to be aware of economic factors that influence observed prices. A short-run rise in prices due to expectations that a new industry may enter the area would not be a good indicator of water values until prices stabilize after expectations either are or are not realized. In contrast, a long-term price effect from stagnation of a water-using industry (copper mining in parts of the Southwest, for example) would be a valid component of water value in the affected region.

To summarize, there are several potential problems in considering water market prices as measures of value appropriate for use by a public agency. First, in an "ideal" market the observed price represents market participants' willingness to pay for the marginal unit of water currently available. Willingness to pay for *additions* to the existing water supply could differ substantially from the market price. Second, current market activities and institutions may favor some water users over others, creating inequitable access to water and income-earning opportunities. Third, market activities may generate externalities—effects of water use and transfer poorly reflected in market prices. Some externalities arise because potential beneficiaries of water supply increases are not market participants and impacts on their well-being would not be reflected in market prices. Finally, observed prices may be influenced to varying degrees by imperfect competition and legal or hydrologic uncertainties.

PRACTICAL CONSIDERATION IN USING MARKET PRICES

Assuming that there are no a priori reasons to suppose that market prices are not appropriate measures of water value, what practical problems would confront an agency seeking to use market prices to value water?

The diversity of institutional settings in which market activities occur affects the practicality of using prices as measures of value. First, there is no a priori reason to believe that prices emerging in one market setting will be relevant to water values in a different area. Second, even within the same market region, prices observed for one type of water right do not necessarily convey useful information about the value of a different type of water right. This underscores the importance of identifying the institutional structures that will govern allocation and use of augmented yields as a first step in valuing those yields. If market prices are used to establish the value of increased flows, they should be prices that emerge from an institutional setting and type of water right closely resembling the institutions and water rights that will characterize augmented yields. Additional flows cannot be valued until decisions have been made regarding who has the right to use the water and under what conditions the right can be exercised and transferred.

Another difficulty involves identification and description of the various water "commodities" in the area of study.[122] Careful study of state water law and local water management institutions is necessary to define and differentiate these commodities.

Gathering information about market prices is a time consuming task. Transactions must be identified from records of state engineers or water agencies. Such records rarely include price data, so contact must be made with market participants or knowledgeable observers to learn about prices associated with specific transactions. Much "digging" may be needed to uncover a representative price, though in some areas the "going" price for a certain type of water right is a matter of common knowledge. This is true of Colorado-Big Thompson unit prices, for instance.

Another practical problem involves deciding which prices are most appropriate for valuing water from supply augmentation projects. In any market region there are many prices for water arising from various types of transactions. For instance, in the lower Sevier Basin prices emerge from rental and sales of irrigation company stocks and occasional purchases of surface or groundwater not represented by company stocks. In Arizona, water prices arise from sales of Type II non-irrigation rights and purchases of farmland with appurtenant irrigation rights. All observed prices may vary seasonally and from year to year, as supply and demand for water fluctuates. Which, if any, of these prices (and at what points in time) are appropriate for a government agency interested in valuing water? In general, prices

should be selected that most closely reflect the conditions under which increased supplies will be made available and the uses to which the water will be applied. If "new" water represents a permanent increase in regional water supplies, then market sale prices for the intended purpose of use might be appropriate. If additional water will be made available sporadically on a seasonal basis, then short-term rental prices may be more appropriate as a reference value. Rental prices vary across seasons and between water uses, and the price selected should correspond to the season and the use for which the additional water will be available. Additional supplies made available in the dry, high-demand months will naturally have more value than the same volume made available in high-flow low-demand seasons.

COMPARISON OF PRICES ACROSS MARKET AREAS

Table 2 summarizes price data collected on purchases of perpetual water rights in the various areas studied. Price observations over time are reported in terms of equivalent 1986 dollars paid per acre-foot of long-term average yield on diversion rights acquired by the buyer.

Understanding price differences across market regions is complicated by the differing economic forces dominant in each region—energy development in the Lower Sevier Basin versus rapid urbanization in central Arizona, for example. Although it would be difficult to demonstrate empirically, Arizona, Colorado and Utah water prices may be dampened by expectations of new water supplies from the Central Arizona Project, the Windy Gap Project, and the Central Utah Project, respectively. Anticipation of new water supplies can decrease incentives to bid water away from existing uses.

Prices tend to be lower when the predominant buyer for the water rights is irrigated agriculture, as with DMAD stock in Utah, and nonagricultural users do not compete significantly for water with agricultural users. Prices tend to be higher where expanding nonirrigation water users are buying water rights and supplies are constrained through institutional barriers, physical supply limits, or both, as in the Gila-San Francisco Basin of New Mexico and the Truckee Meadows in Nevada.

Table 2.—Weighted average prices for representative sales of perpetual water rights, in constant 1986 dollars per acre-foot.

	Arizona[a]		Colorado[b]		Nevada[c]	New Mexico[d]		Utah[e]	
Year	Avra Valley	Type II	C-BT	Twin Lakes	Truckee River	Gila	San Francisco	DMAD	Groundwater
1961			130		150				
1962			150		140				
1963			220		170				
1964			370		150				
1965			440		130				
1966			530		160	1,790			
1967			560		160				
1968			600		150	1,300			
1969			850		140				
1970			920	900	140				
1971	430		860	1,400	130	1,630			
1972	420		860	2,400	120				
1973			930		2,400	120			
1974			1,050		110	1,240		330	
1975	570		1,090		100				
1976	570		1,330	2,300	90	1,150		300	
1977	630		2,540		90	1,420	510	550	
1978			2,590		80	3,210	480	550	
1979	700		3,050		70	2,070	440		
1980			3,600	11,820		3,270		2,440	2,440
1981			2,990	10,950		2,990	1,110	1,200	1,150
1982			1,880		470	1,780	510	750	680
1983			1,600		1,730	1,460		430	
1984	870	560	1,460		1,570	2,520	1,460	430	740
1985		920	1,080			2,050	1,140	350	710
1986	630	1,430		8,180			1,210		
1987		1,000				1,810	1,110		

[a]*Data on the sale of Type II nonirrigation groundwater rights were obtained from investment managers, real estate developers, and attorneys. Data on Tucson's acquisitions of Avra Valley land and water rights were provided by city officials.*

[b]*Data on sales of C-BT units were obtained from real estate brokers and from public water districts and municipal water agencies. Most price data for Twin Lakes stock were made available by the towns and cities which purchased the rights in the mid and late 1970s. Estimates of earlier market prices were provided by local individuals knowledgeable about the sales. Recent price data were collected from a private attorney.*

[c]*Summary information on water rights acquisitions and prices up to 1979 were available from records provided by Sierra Pacific Power Company. Data on purchases since 1979 were gathered from reports filed by Sierra Pacific with the Nevada Public Service Commission, attorneys, engineers, and other private individuals.*

[d]*Descriptive data on water rights transfers, excluding price information, were available from records maintained by the New Mexico State Engineer. Price data from a sample of these records were collected by contacting individuals involved in the transactions. Records of water rights purchases by Silver City are public information.*

[e]*Sales of groundwater rights and ditch company water stock were collected from real estate brokers, attorneys, bankers, and other private individuals. Quantities and prices of water rights purchased by the Intermountain Power Project is public information.*

The interaction of shifting supply and demand for water rights along with the variety of institutional settings found among the study areas cause many different types of price responses to be observed. In southern Arizona, where declining groundwater tables and high energy prices have made water resources scarcer than in many other areas studied, water rights prices remain relatively low. Institutional uncertainties involved in transferring water rights, and the existence of alternatives to water rights transfers (the primary alternative being water service from the Central Arizona Project) reduce incentives for market transfers.

Northeastern Colorado provides an example of how perceptions of water scarcity may rapidly increase water rights prices even though long-term supplies remain relatively inexpensive and abundant. A speculative boom in the mid–1970s drove real prices for water rights to unprecedented levels by the early 1980s, although the gradual transfer of water rights from agricultural to nonagricultural use continued without any major change. Widespread concern that increasing urban water demand was quickly outstripping supply led to sharp increases in prices. Gardner and Miller[120] suggest that prices peaked at values equal to the capitalized marginal demand for water by municipal users. Agricultural water rights holders believed that they each had a high probability of being able to transfer their water rights to a high-valued municipal or industrial water use. For a brief period of time the opportunity cost to agricultural water rights holders of retaining their water rights was equal to the value of the water in urban uses.

Shifts in demand for water rights, or the perception of future shifts in demand for water, has led to rapid water rights price changes in other market areas as well. The impact of a large new water buyer can be observed in Utah water prices as the Intermountain Power Project entered the Utah market in the late 1970s. Prices in the Gila-San Francisco Basin, which had been slowly rising for a number of years, took a sudden turn upwards in the late 1970s when the Exxon Corporation began to acquire water rights for its new mining operation.

It is instructive to consider not only what forces drive water rights prices up, but what forces allow them to fall. Water rights prices in northeastern Colorado probably fell at least partially in response to the construction of the Windy Gap Project in the early 1980s. It is also likely that declining interest rates, the onset of recession, and a faltering farm economy (leading to an increase in the volume of water rights offered for sale) all contributed to the decline in water market prices. In Utah, the scaling back of the IPP to one-half its planned size cut into the speculative bubble that had risen around the project and prices fell. The stabilization of water rights prices in Nevada may be a signal that panic buying of water rights has slowed since private and government organizations agreed upon a system to assure an orderly transition of water rights from agricultural to municipal use. In New Mexico, nominal water rights prices have stablilized and real prices have declined since Exxon (and Boliden) completed their acquisition program.

Every market studied is influenced to some degree by one or more of the four market characteristics discussed earlier and summarized in table 1. In addition, the practical considerations discussed earlier affect every market to varying degrees. Prices for irrigation rights in Avra Valley, Arizona, for example, emerge from transactions between a single buyer (the City of Tucson) and a limited number of potential sellers (Avra Valley farmers). Recorded prices include land and all improvements. It is unclear what the City will do with the land and improvements and it is therefore difficult to assign a value to the water, as distinguished from the value of the whole property. The water value picture in the Tucson area is further complicated by uncertainties surrounding Indian water rights. The 1982 Southern Arizona Water Rights Settlement Act gave the Tohono O'odham Tribe rights to 76,000 acre-feet of water annually, to be delivered by 1992. The Act provides for leasing of tribal water rights to water users within the Tucson Active Management Area under specific conditions and with the approval of the Secretary of the Interior.[123] The potential (as yet unrealized) for the participation of the tribe in Tucson area market activities creates a great deal of uncertainty regarding future water supplies and prices. Given these considerations, current market prices do not appear promising as a measure of water value useful to a public agency.

One of the clearest implications of this research is that observed prices, even where they are easily discoverable, should not be used as measures of value until price formation processes and market characteristics have been thoroughly studied. Such an analysis will typically find that observed prices deviate from a social value of water, suggesting that market information be supplemented by nonmarket measures to assess water values.

NONMARKET INDICATORS OF WATER VALUES

Gibbons notes[124] there is a pressing need to understand water values across economic sectors. Examination of marginal benefits in competing uses would identify disparities in value and potential for promoting more efficient water use. She outlines several approaches to estimating water values in the absence of appropriate market prices. Contingent valuation approaches elicit value information directly from water users. Inferential approaches rely on market-like transactions to infer water values. If adequate price and quantity data are available, a demand curve can be constructed and marginal values estimated at various quantities demanded. Information on physical productivity of water in a production process can be used to construct production functions and to estimate water's marginal value product, given a specific output price. Budget information on production processes can also be used to impute the residual fraction of total output value to water inputs, if all other inputs are paid at their marginal productivities.

Techniques for estimating the marginal value product of water in agricultural production generally rely on programming methods because of the absence of a wide

range of observed water prices for agriculture. Kelso et al.[7] used linear programming to develop aggregate marginal demand curves for irrigation districts in Arizona and used these demand functions to compare the value of water in agriculture and related sectors of the economy. Howitt et al.[125] used a quadratic programming model of field crop production to derive a demand schedule for irrigation water in California's Central Valley. Gardner and Miller[120] computed the marginal value product of irrigation water in the C-BT service area by a residual computation method, subtracting the costs of all inputs except water from gross farm income.

A number of researchers have developed models of municipal water demand. Howe and Lineweaver[126] in an early study using cross-sectional data from 21 metropolitan areas, found that price elasticity of demand differed substantially between indoor and outdoor use, as well as between eastern and western metropolitan areas. Methods of estimating urban demand functions continue to be refined. Martin et al.[127] critiqued the use of conventional regression analysis to estimate demand in areas where water rates follow a block rate schedule, and outlined an interactive regression procedure that produces unbiased estimates of demand function coefficients in a block rate setting. Based on these estimates, their study concluded that real price is an important (though not the only important) component affecting consumer demand in Tucson.

Methods for valuing water in recreational and other instream uses are less well developed. Krutilla et al.[128] described a procedure to estimate the instream energy value of increased flow from augmentation projects. Martin and Cory[129] commented on this study, emphasizing the importance of comparing water augmentation projects to agricultural water transfer policies in terms of both net social benefits and the incidence of benefits and costs on taxpayers, agriculture, and municipal and industrial interests. Daubert and Young[130] applied contingent valuation methods to instream flows and found that seasonal reallocation of flows between irrigation and recreation could increase social benefits associated with surface water use.

Lack of household, industry, and farm level data on water use is a major constraint on widespread use of water demand functions as an aid in valuing water for agricultural, industrial, and residential uses. Lack of widely accepted methodologies, along with absence of data, make estimation of instream water values difficult. Supplementing market prices with nonmarket information on water values can be a difficult and time consuming process. However, inferential and contingent valuation techniques have been applied to wildlife, scenic amenities, recreation opportunities, and air and water quality. Research attention needs to focus on adapting these methods to valuing water in alternative uses.

SUMMARY AND IMPLICATIONS

Western water transfers take place under diverse institutional, economic, and hydrologic conditions. Water markets are characterized by various degrees of imperfect competition, third-party impacts, hydrologic and institutional uncertainty, and distributional effects. These characteristics affect the appropriateness of market prices for use as measures of value. Are prices set or constrained by government policies or dominant market participants? If so, then market prices are not competitively determined. Do market transfers impose uncompensated costs or benefits on third parties? If so, then observed prices do not include values associated with the transfers. Are transfers constrained by physical, institutional, and economic uncertainties? If so, then the level of trading and the performance of the market will tend to compensate for these uncertainties, and this process may distort prices as a measure of water values.

While nearly all market prices deviate from an ideal measure of value, observed prices can provide a rough indicator of the marginal value of additions to regional water supplies if the additional volume of water made available is small relative to the region's total supply. For small supply increases, observed prices may approximate current market participants' marginal willingness to pay for additional water supplied. However, market prices still will not reflect nonmarket water use and third-party impacts of market activities. When the additional volume of water is significant relative to existing supplies, estimation of water's marginal value is more difficult. Marginal values for substantital additions to supply could differ significantly from current market prices. The possibility that substantial increases in water supply could attract new water users into a region and change the structure of demand for water must be considered. For instance, rapid urban growth in southern Arizona is stimulated by the perception that the Central Arizona Project ensures a reliable and adequate regional water supply for expanding cities.

Institutional arrangements that govern allocation, use, and transfer of water determine who bears the costs and who reaps the benefits of water supply development. Information regarding how much new water will be available to various user groups, at what prices, and under what restrictions on use and transfer is essential to the valuation process. Owing to the complex nature of water rights in many regions, it is possible that the transactions costs associated with allocating of new water could exceed the marginal value of that water.

Estimating benefits of additional water availability, using market prices and nonmarket information on water values, is only one step in evaluating a supply augmentation proposal. The impacts of the proposed project must be identified. Will the project affect the well-being of regional residents, apart from the increased water supply? Project side-effects involving environmental quality, employment and recreational opportunities must be included in evaluating the costs and benefits. Will the supply augmentation project affect relative income and access to water among farmers, municipalities, Native Americans, or other major water interest groups? Projects that aid in resolving conflicts and accomplishing regional distributional objectives may have social or political value not typically reflected in economic evalua-

tions. The overall merits of water supply enhancement must be gauged by weighing estimated benefits against total costs associated with the project. Above all, supply augmentation proposals must be compared with alternative water management strategies, including increased water conservation and transfer of existing supplies from lower valued uses to higher valued uses.[129] Only augmentation projects demonstrated to be the lowest cost alternative for achieving policy objectives should be approved.

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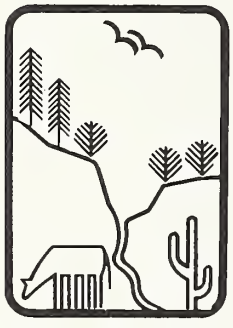
Rocky Mountains



Southwest

Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526